

Prospective and Retrospective Cues for Sensorimotor Confidence in a Reaching Task

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VSS Perception and Action
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What is sensorimotor confidence?

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Why do we care? Sensorimotor confidence allows us to quickly assess if an action needs to be repeated or recalibrated prior to experiencing the consequences of its success or failure.

Temporally Distinct Cues

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Prospective Cues

available prior to the action

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Prospective Cues

available prior to the action

- Sensory information

Temporally Distinct Cues

Prospective Cues

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- Sensory information
- Prior experience with task

Temporally Distinct Cues

Prospective Cues

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- Knowledge of motor noise

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Retrospective Cues

depend on information available after the action and specific to a each action itself

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Retrospective Cues

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- Proprioception

Temporally Distinct Cues

Prospective Cues

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Retrospective Cues

depend on information available after the action and specific to a each action itself

- Proprioception
- Knowledge of proprioceptive noise

Temporally Distinct Cues

Prospective Cues

available prior to the action

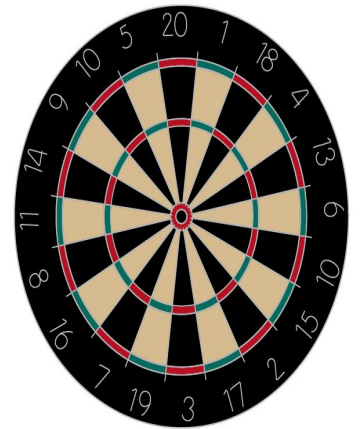
- Sensory information
- Prior experience with task
- Knowledge of motor noise

Retrospective Cues

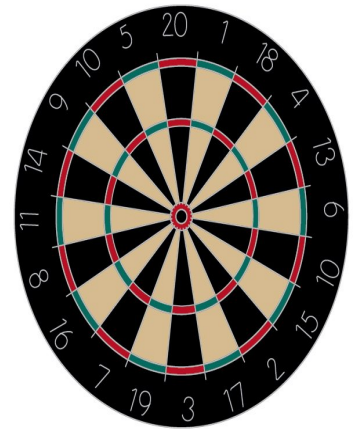
depend on information available after the action and specific to a each action itself

- Proprioception
- Knowledge of proprioceptive noise
- Visual feedback (where available)





PROSPECTIVE CUES



PROSPECTIVE CUES

Distance to target





Location reliability

PROSPECTIVE CUES

Distance to target



Internal Measures

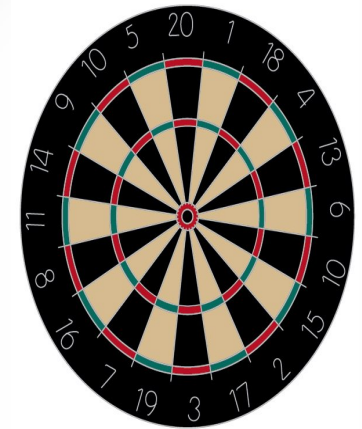


Location reliability

PROSPECTIVE CUES

Distance to target





Location reliability

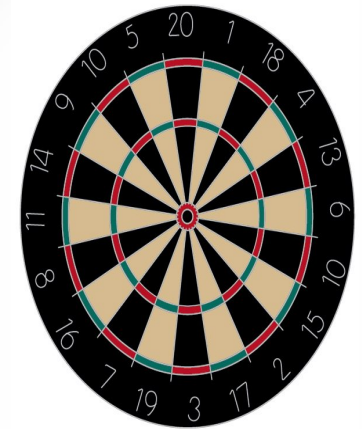
PROSPECTIVE CUES

Distance to target





Motor noise

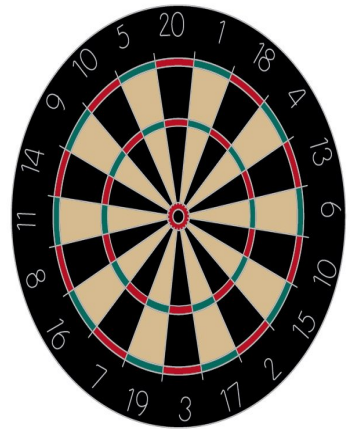


Location reliability

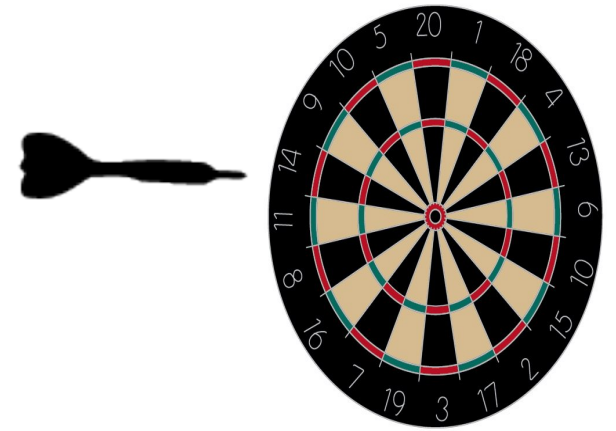
PROSPECTIVE CUES

Distance to target



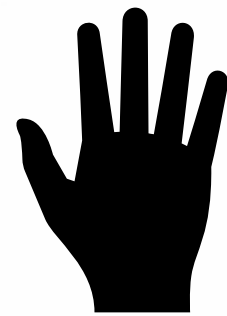


ACTION

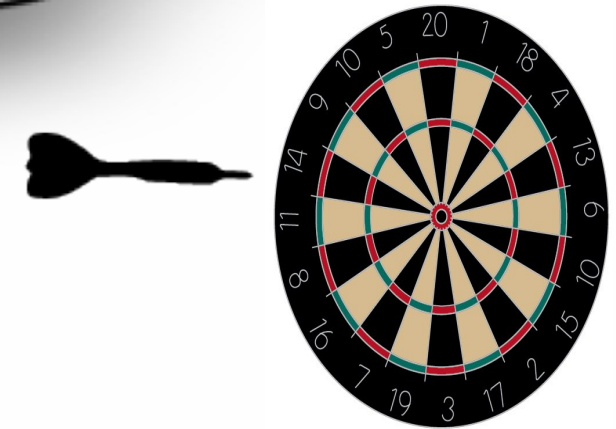


ACTION

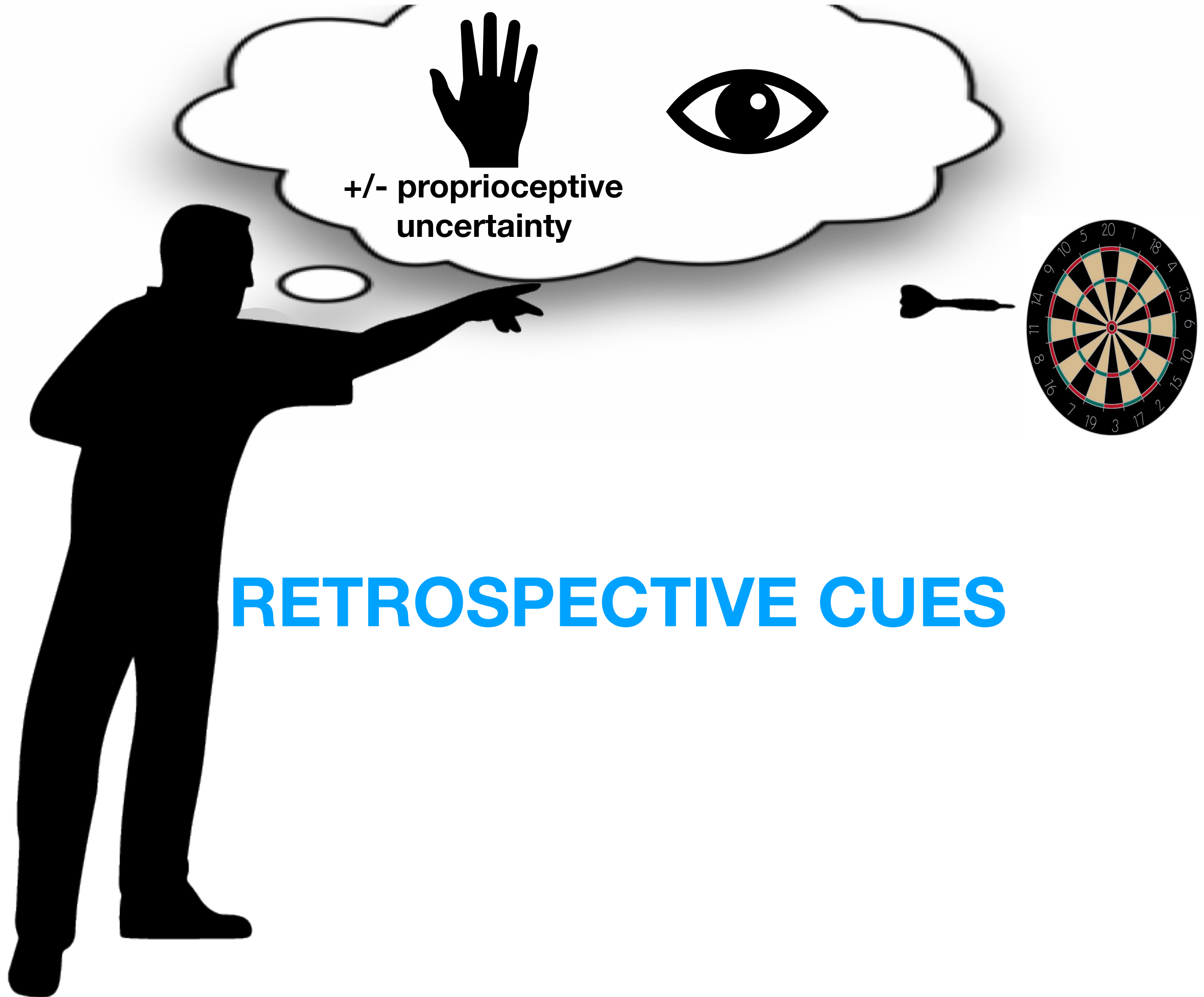




**+/- proprioceptive
uncertainty**

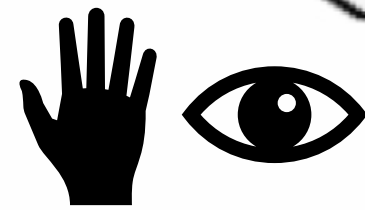


RETROSPECTIVE CUES

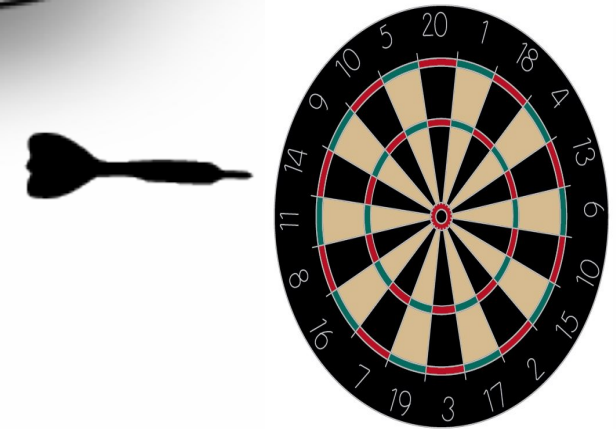


RETROSPECTIVE CUES

Motor noise

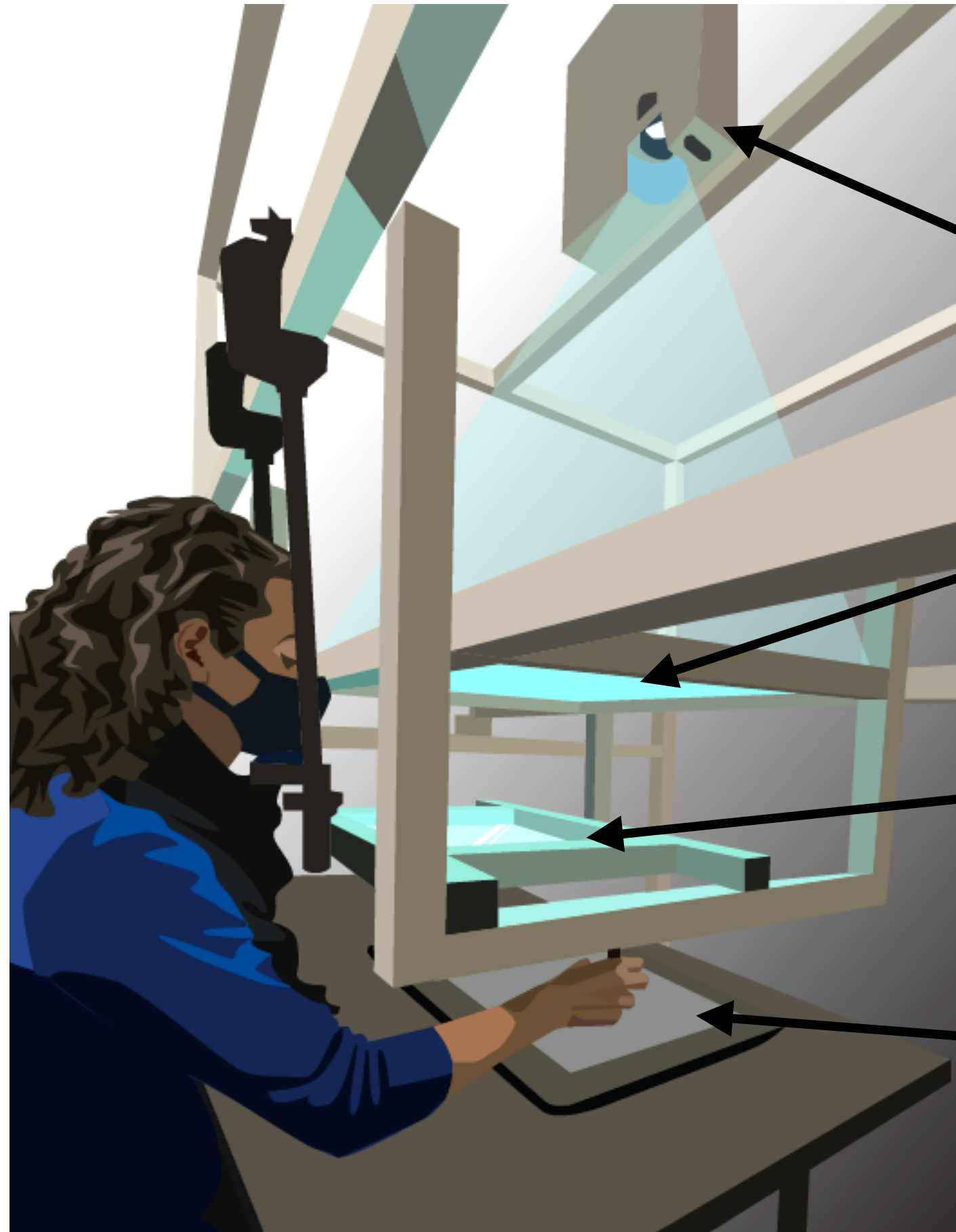


+/- proprioceptive
uncertainty



SUCCESS?

- How do the cues at these two time points contribute to the final sensorimotor confidence judgment?
- Are they always incorporated together or do observers depend only on one or the other cue?



Projector

Screen

Mirror

Tablet

Motor Awareness Task

How well can you estimate the location of your hand in space?

Purpose: To independently measure the participant's proprioceptive noise.

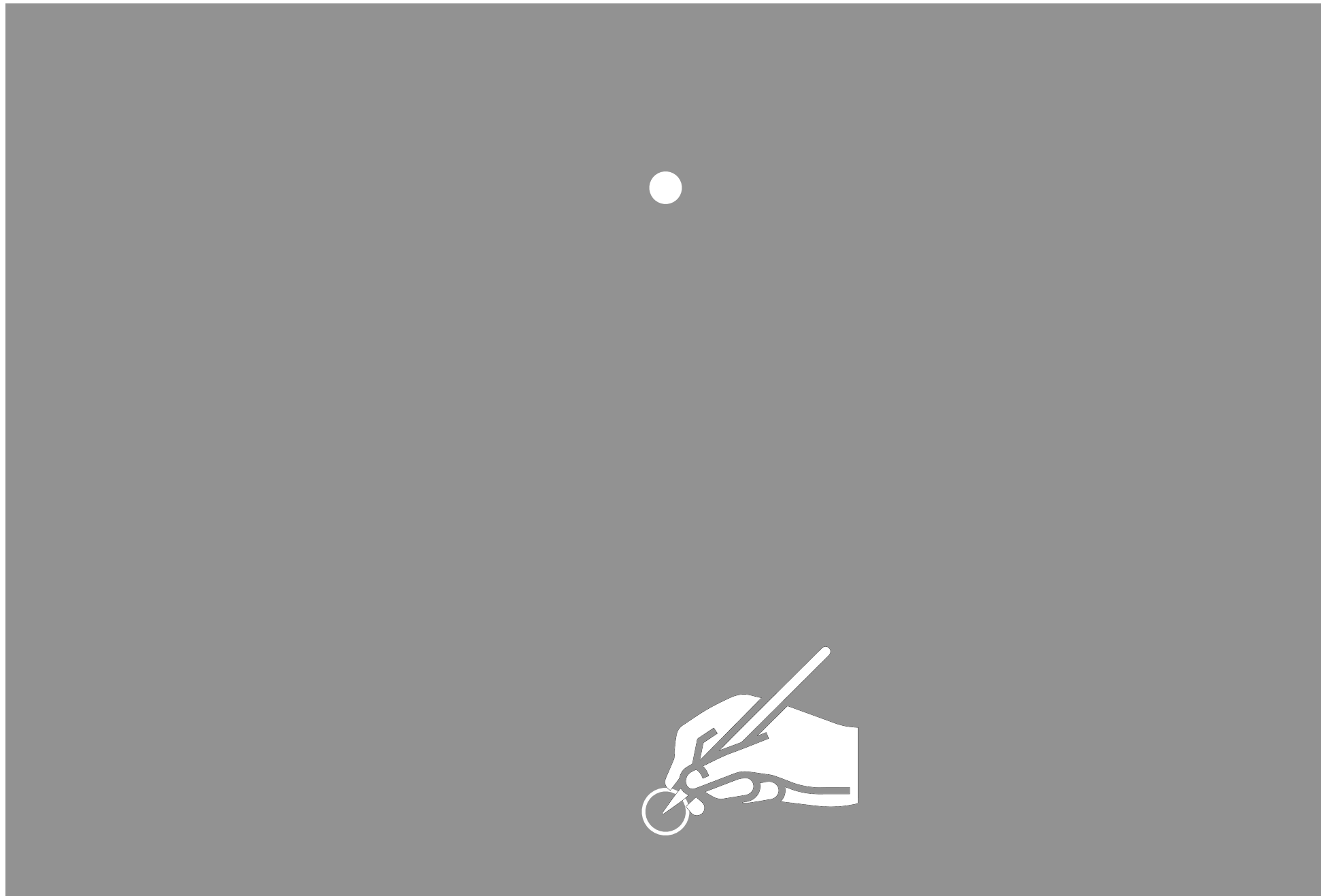
Motor Awareness Task



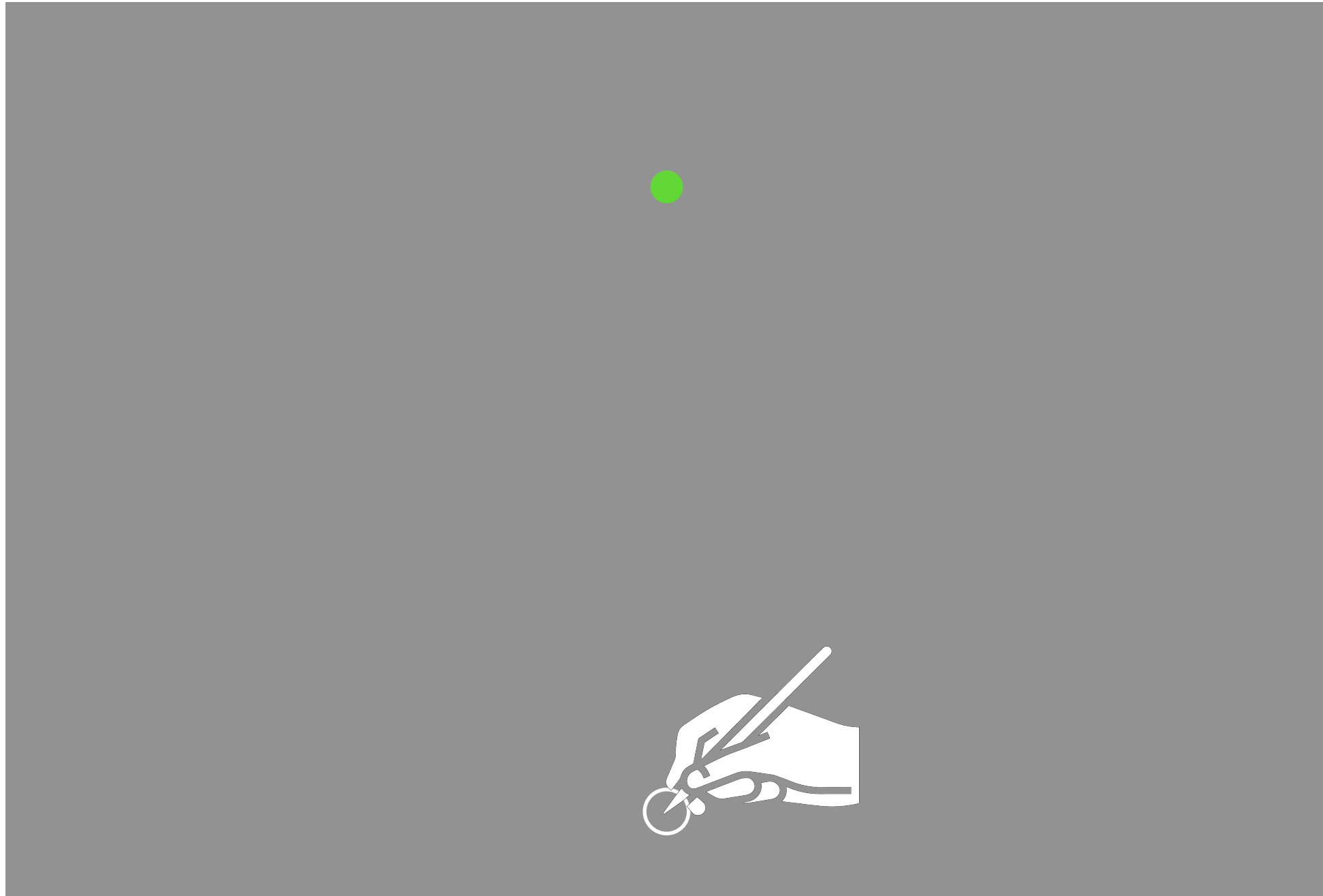
Motor Awareness Task



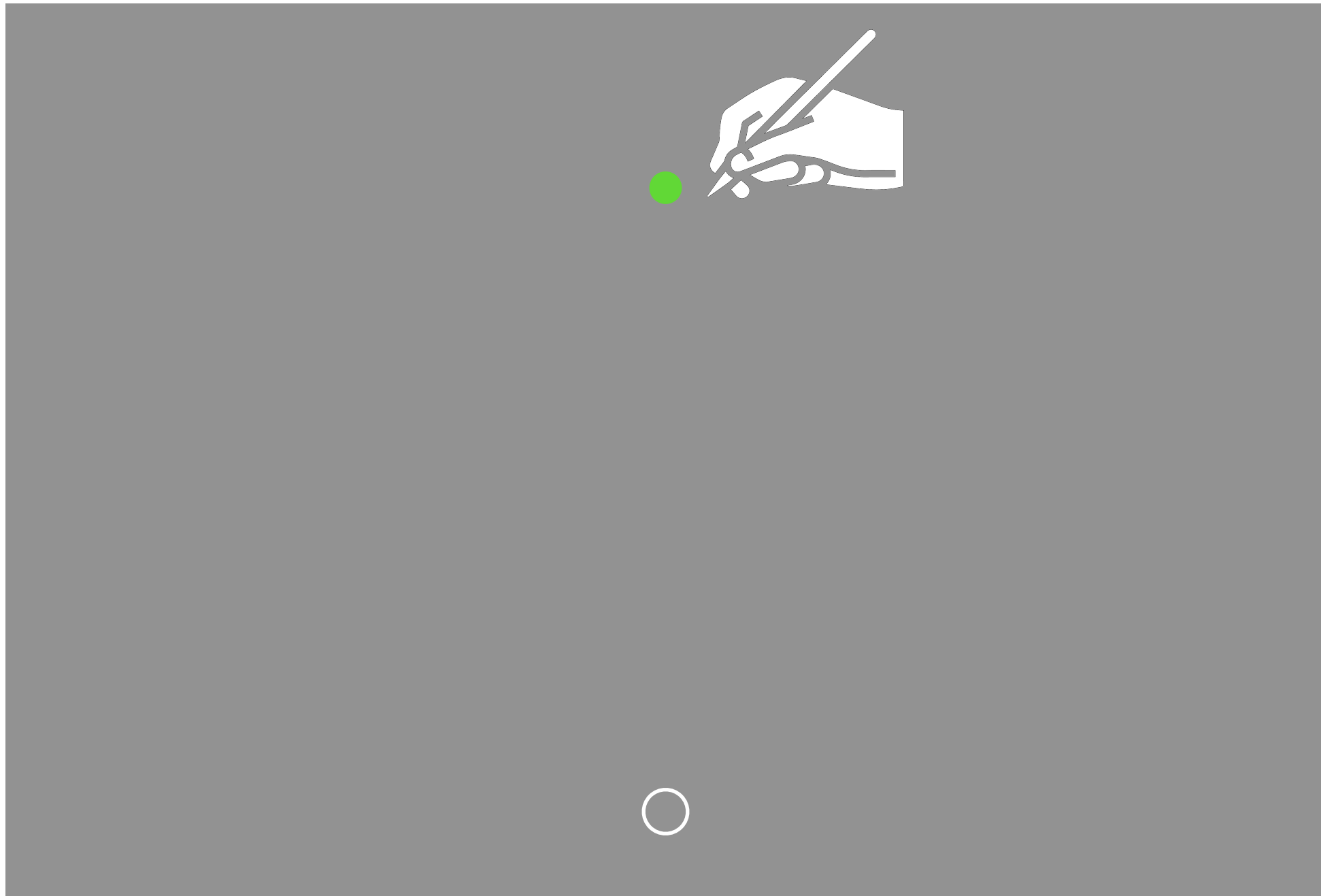
Motor Awareness Task



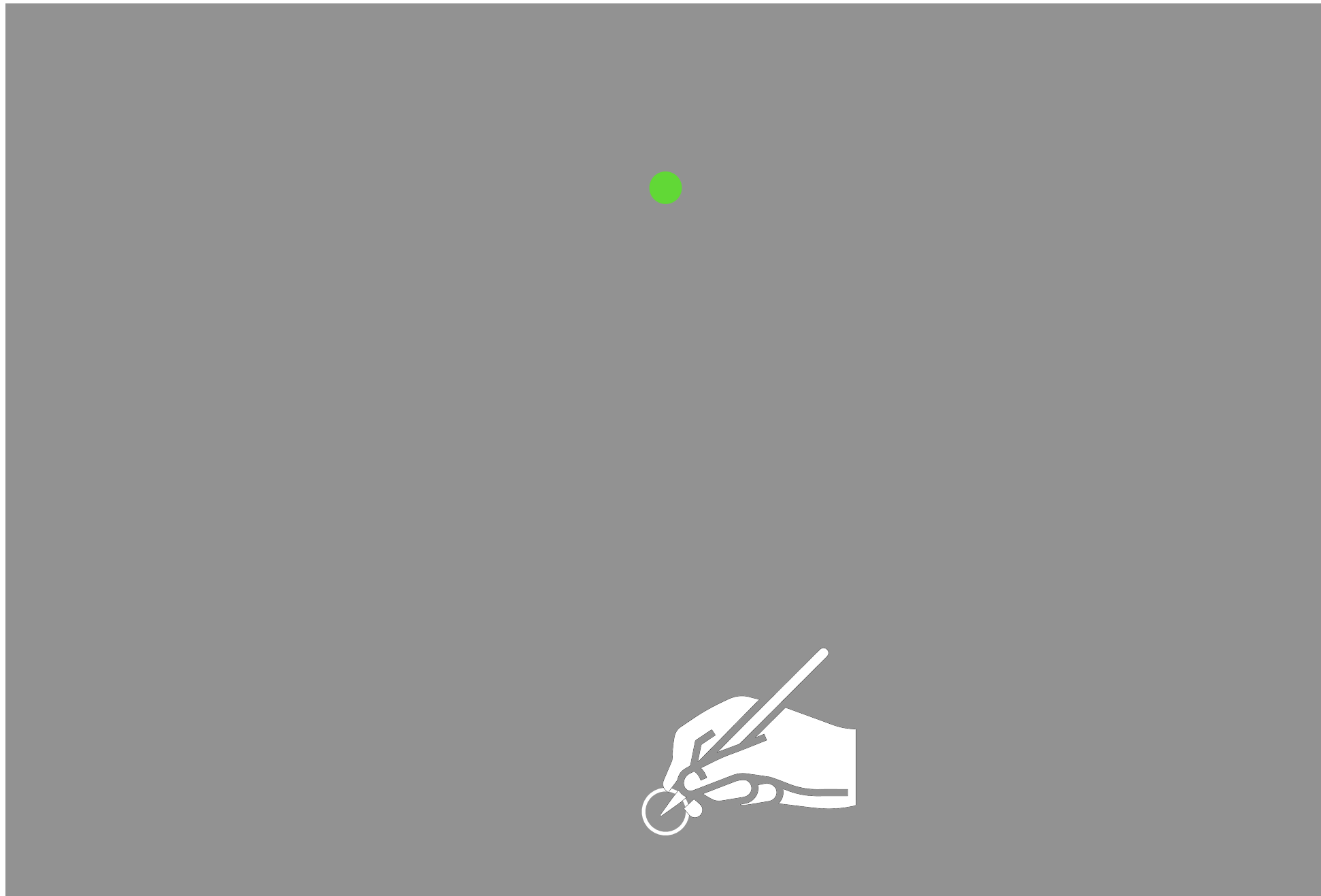
Motor Awareness Task



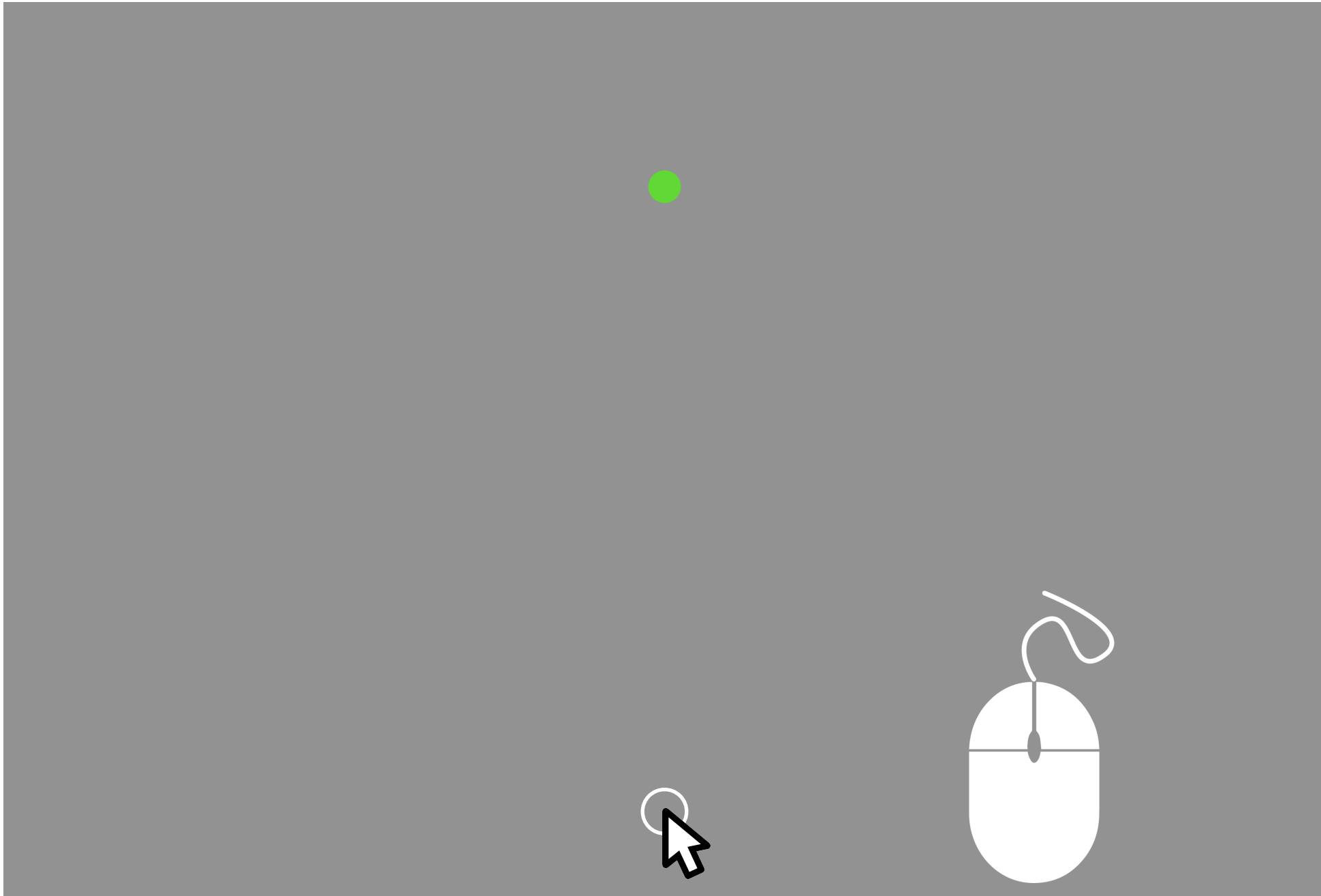
Motor Awareness Task



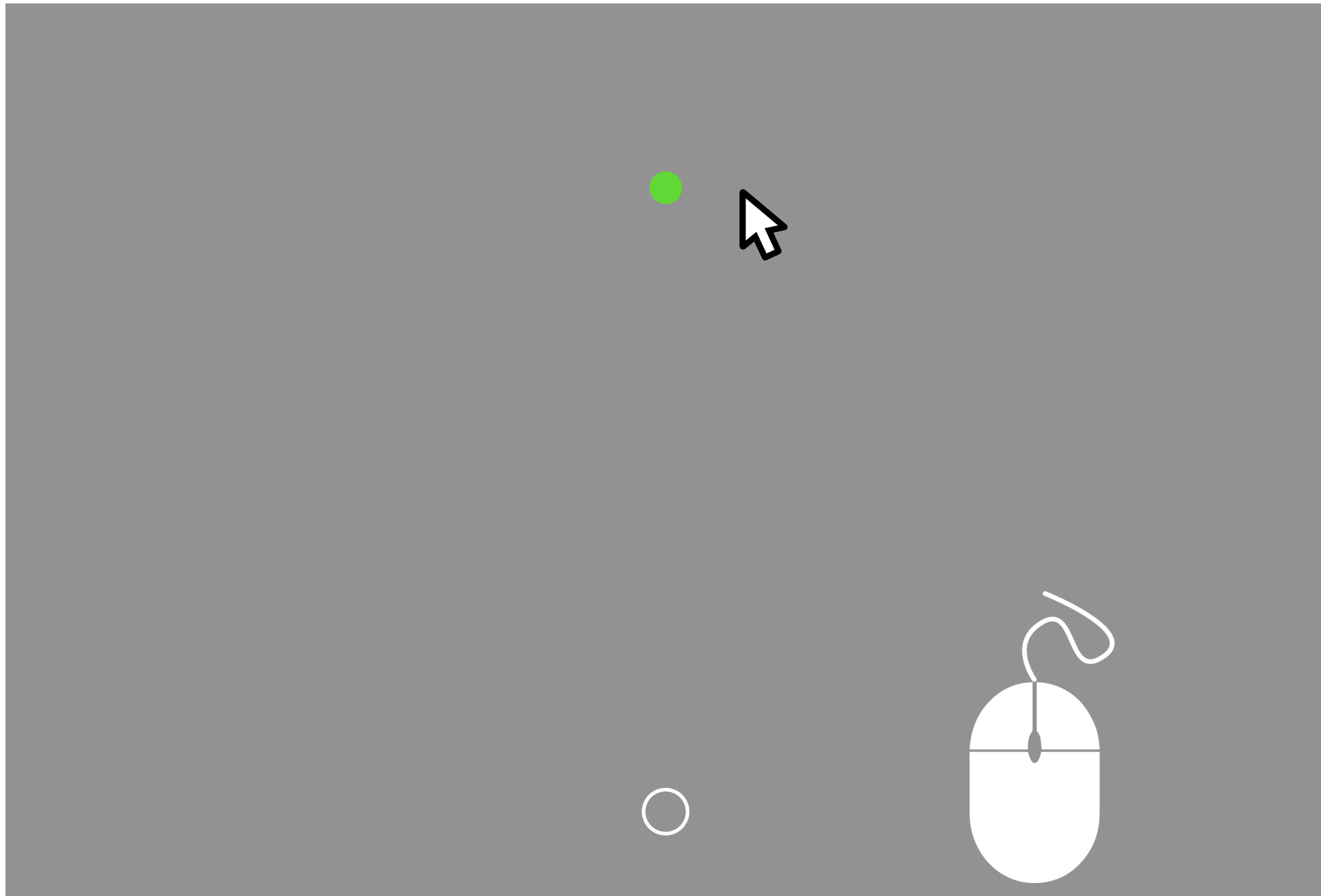
Motor Awareness Task



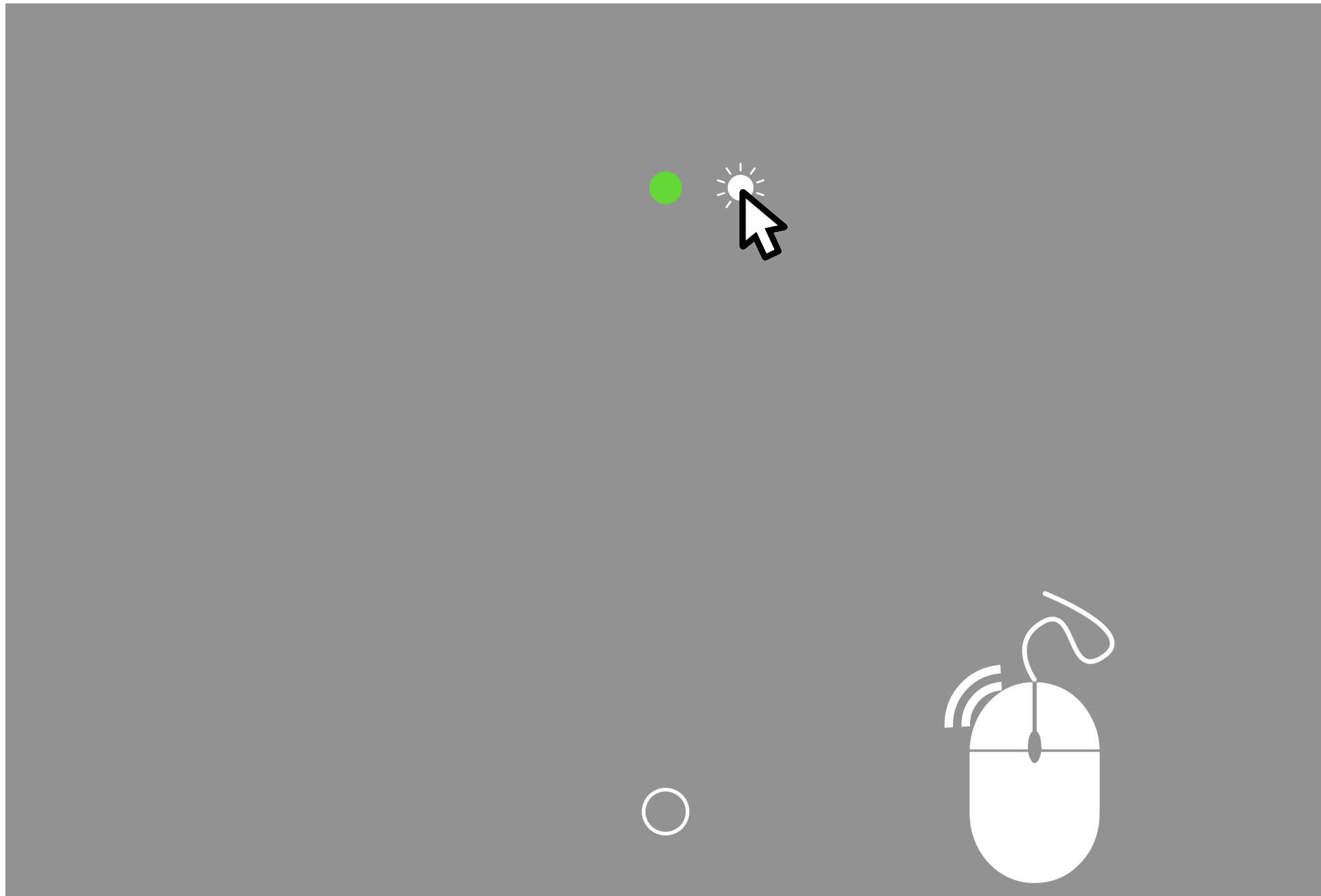
Motor Awareness Task



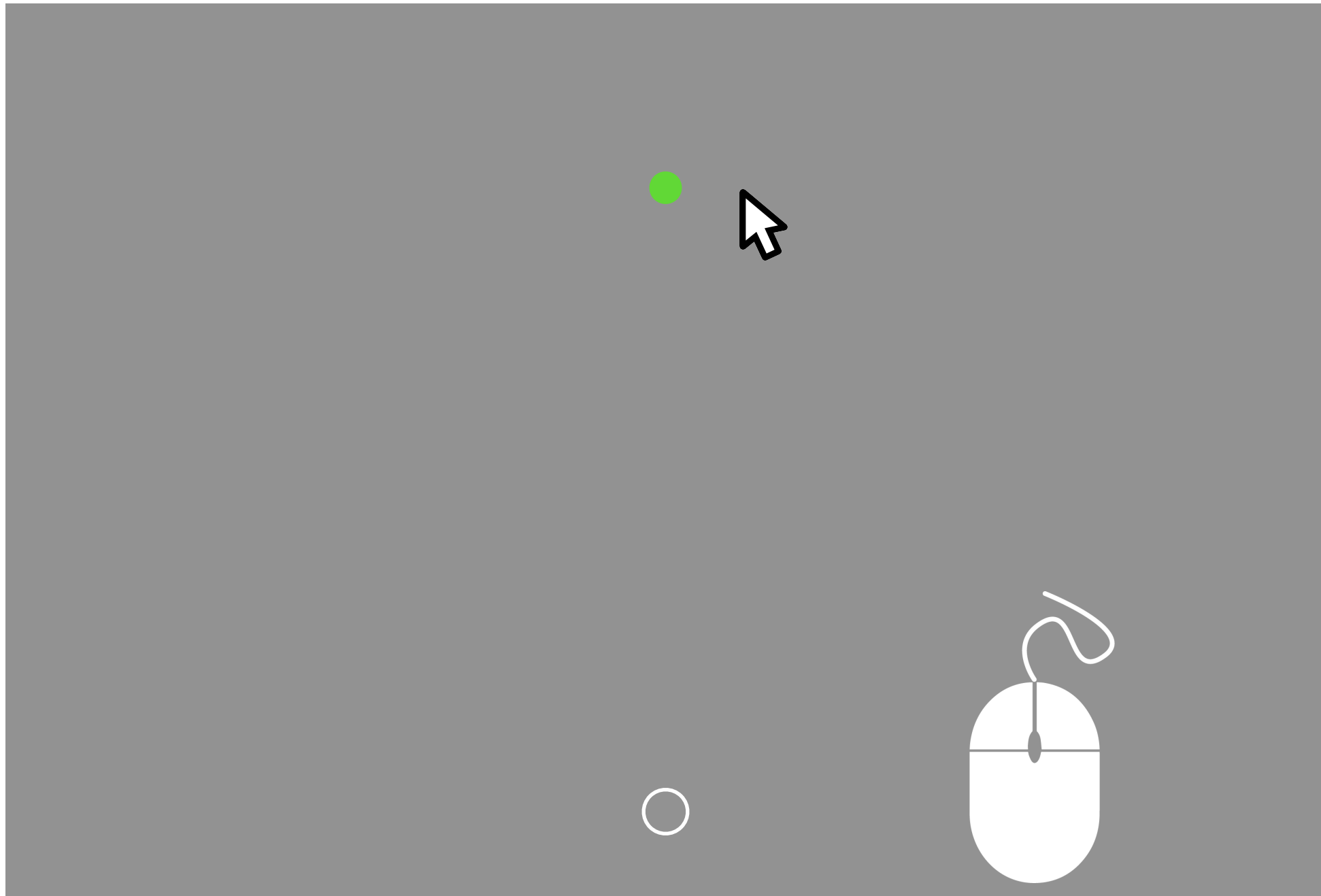
Motor Awareness Task



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Motor Awareness Task

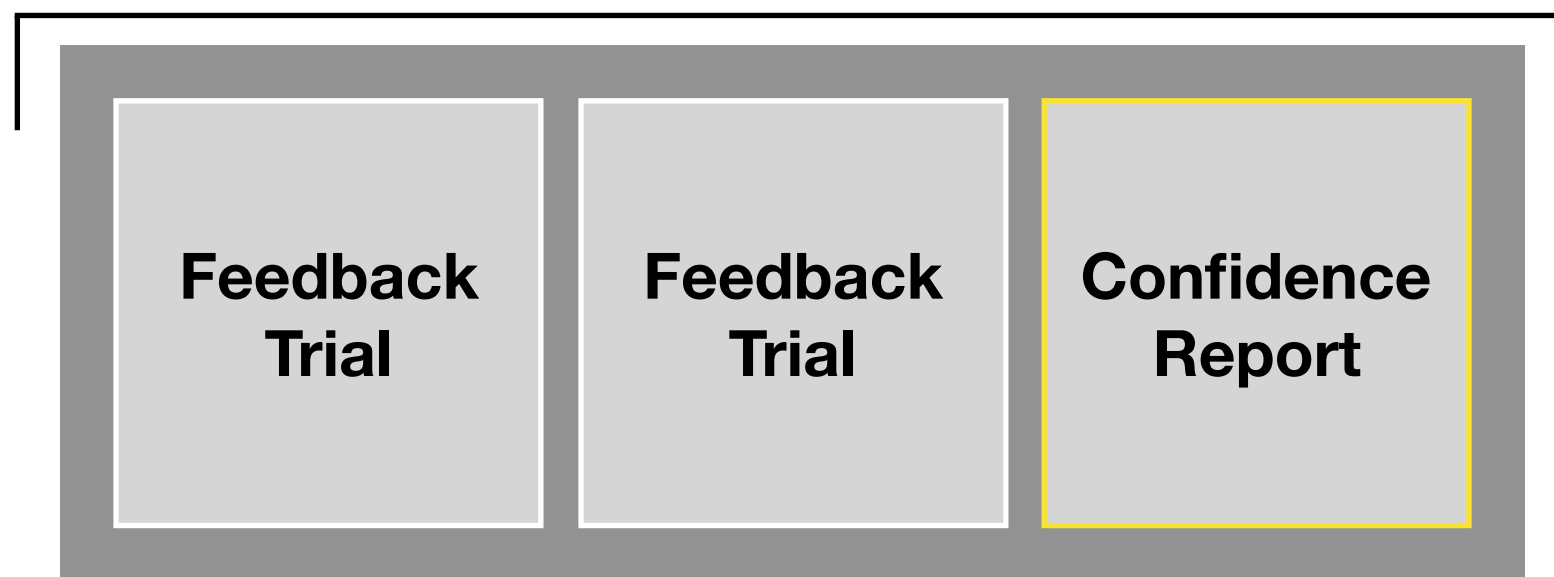


Confidence Judgment Experiment

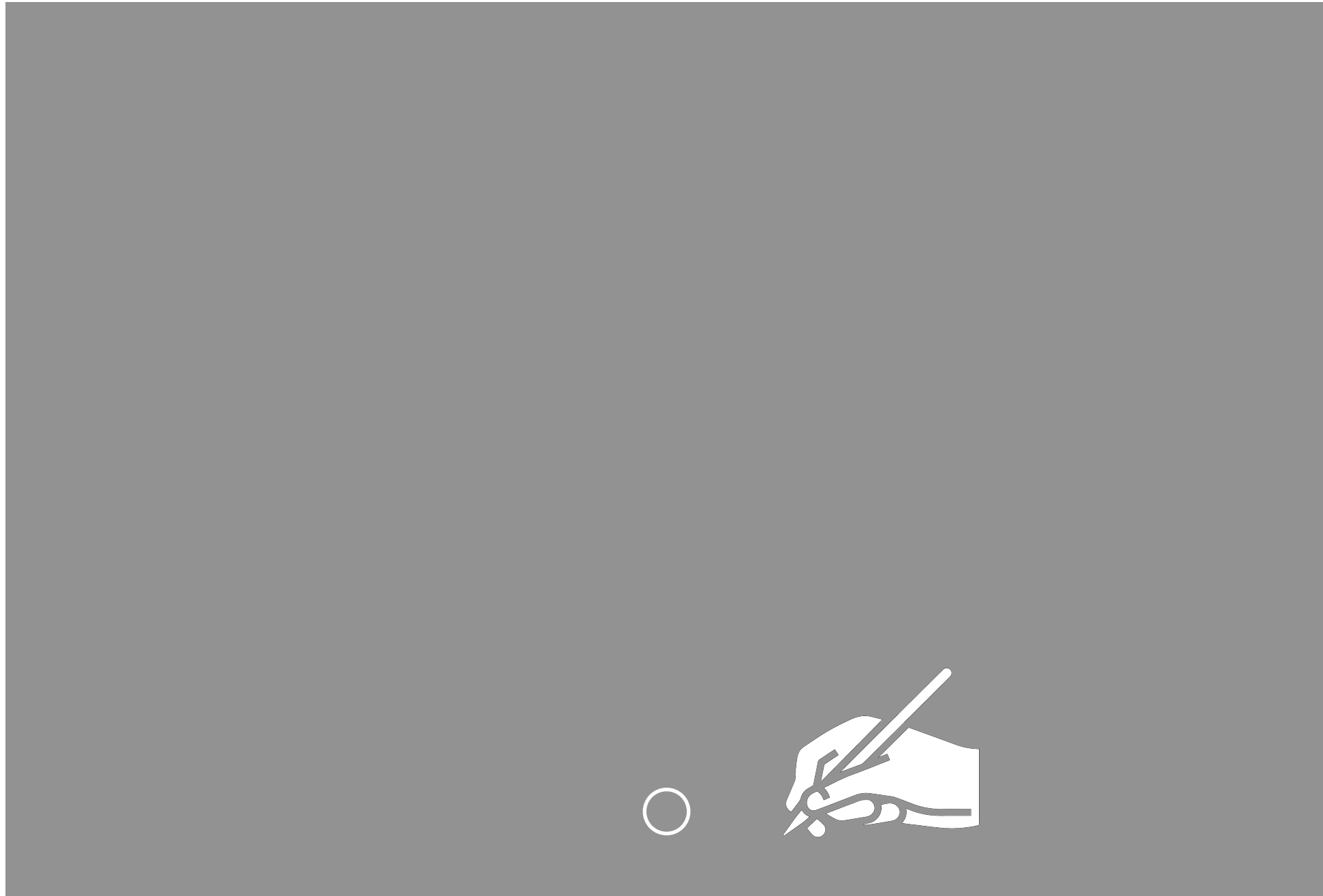
Task: Report of confidence on unseen reaches to a visually cued target location.

Feedback: Presented on the two trials prior to each confidence judgement.

Triplet of Trials



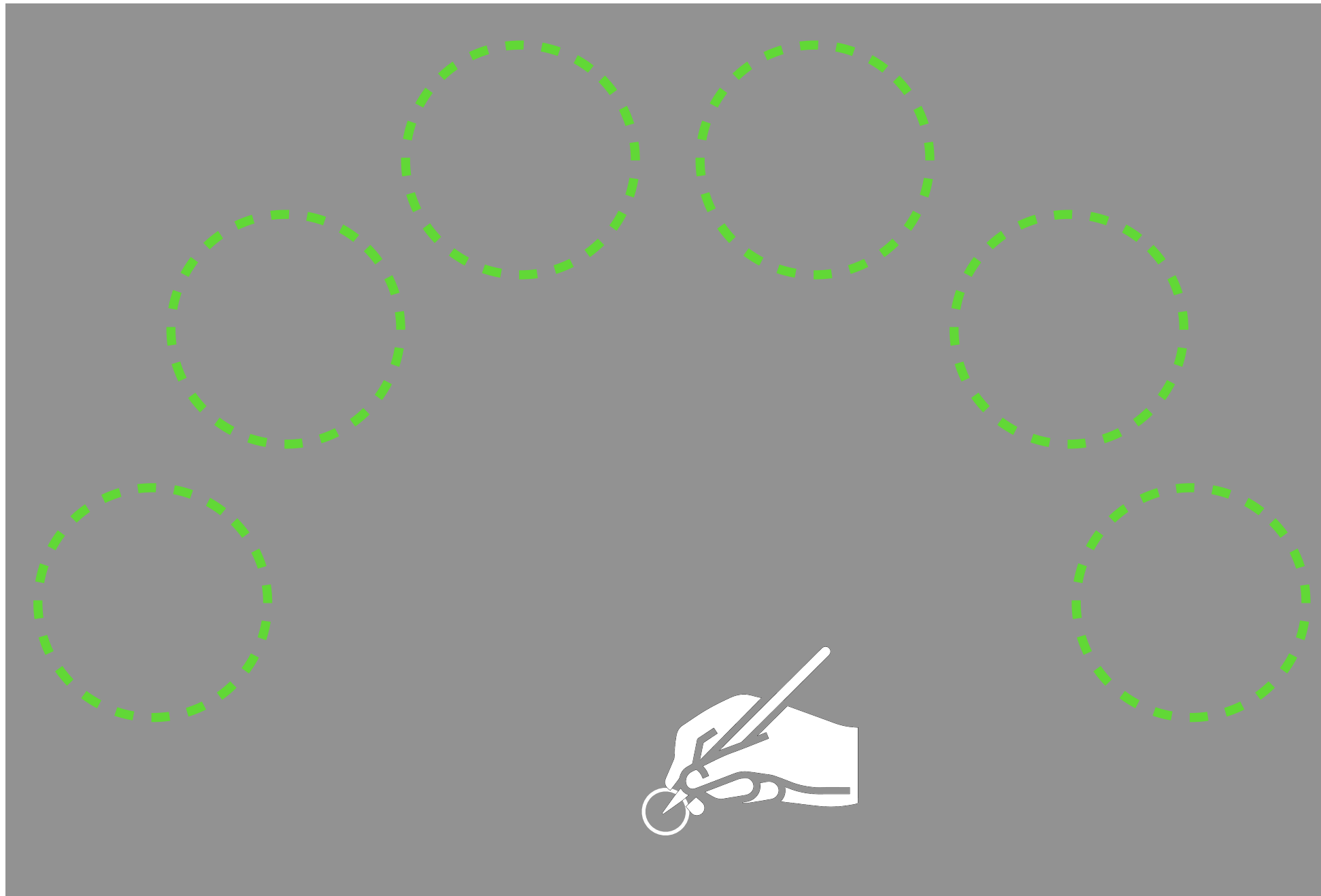
Experimental Paradigm



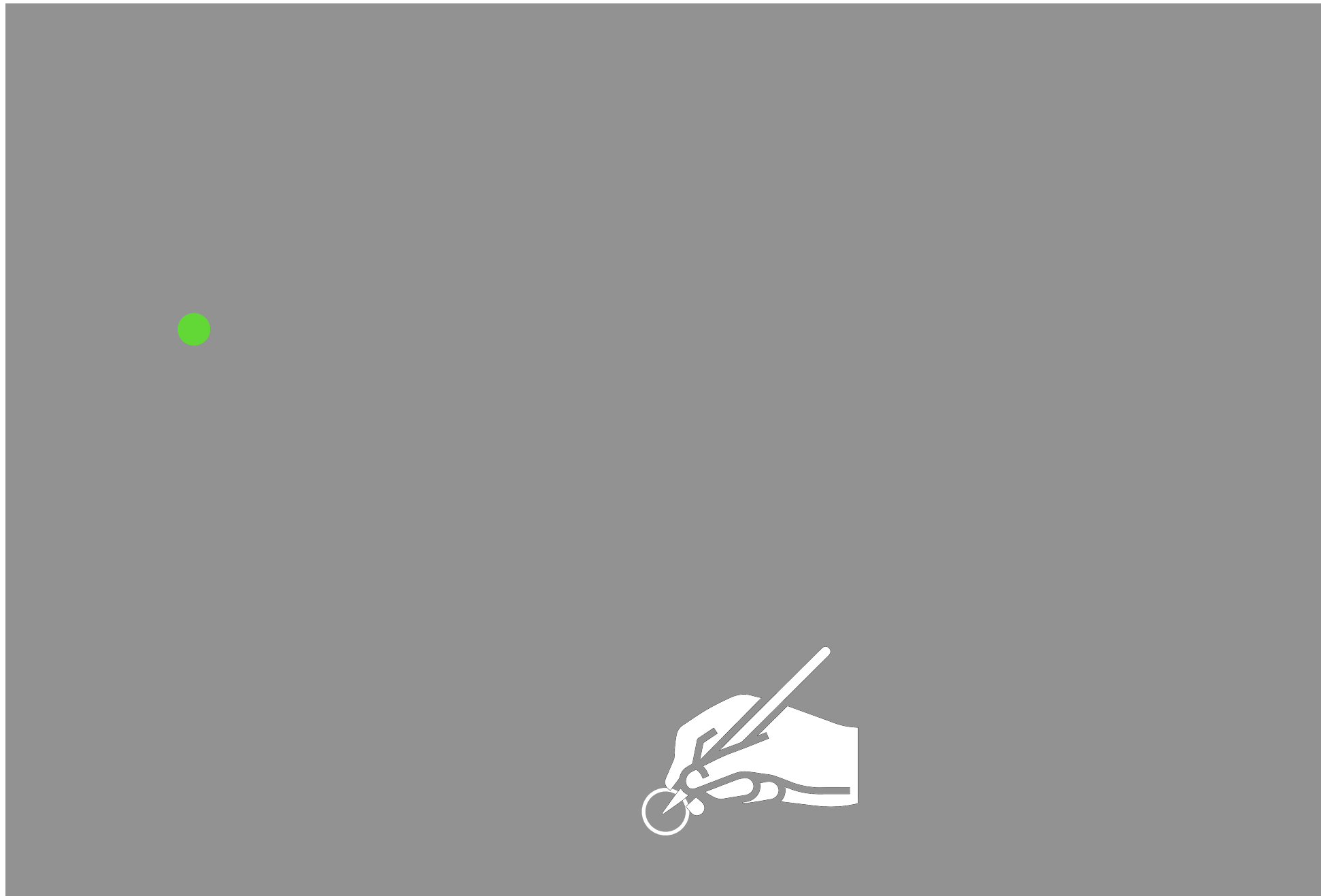
Experimental Paradigm



Experimental Paradigm



Experimental Paradigm



Experimental Paradigm



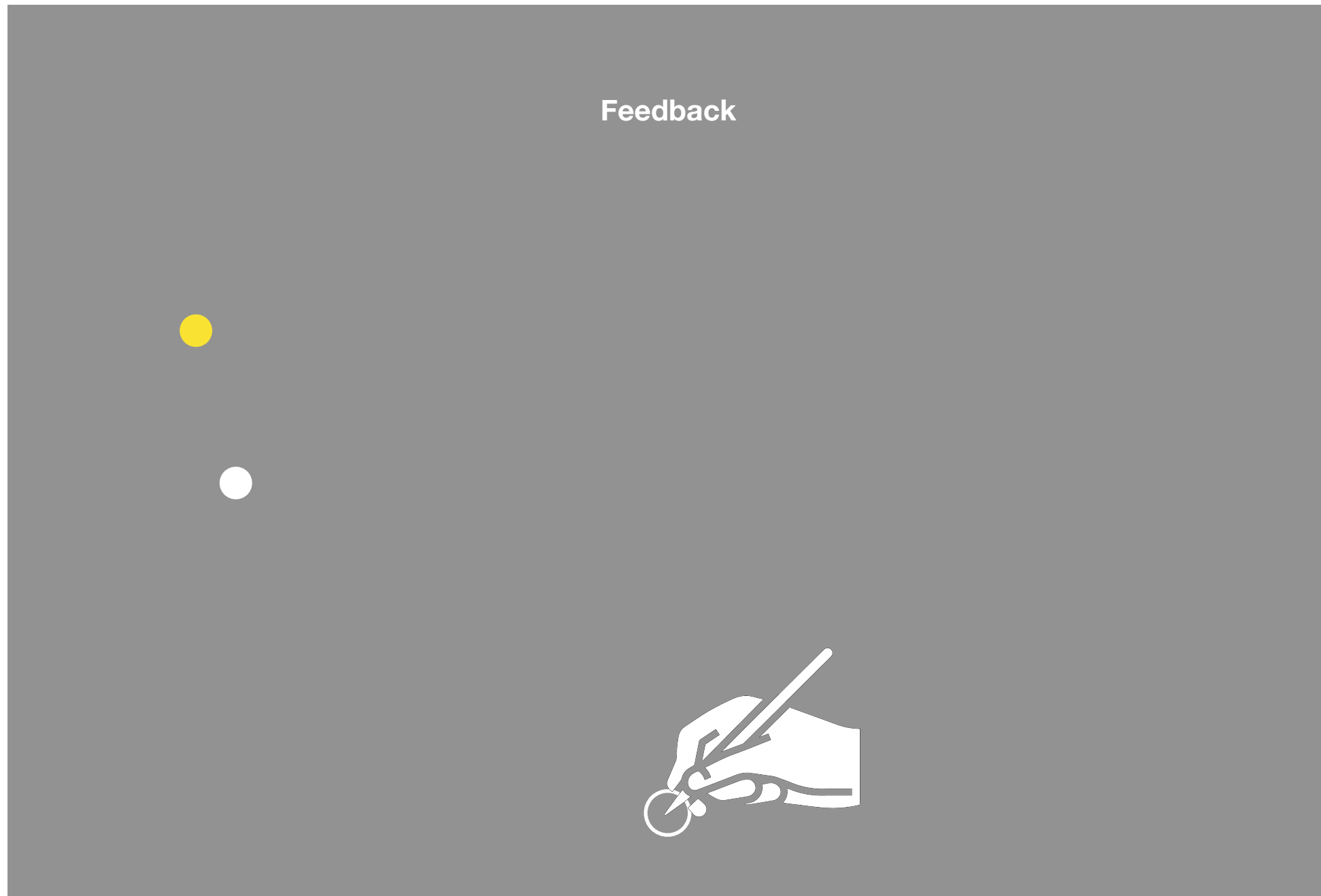
Experimental Paradigm



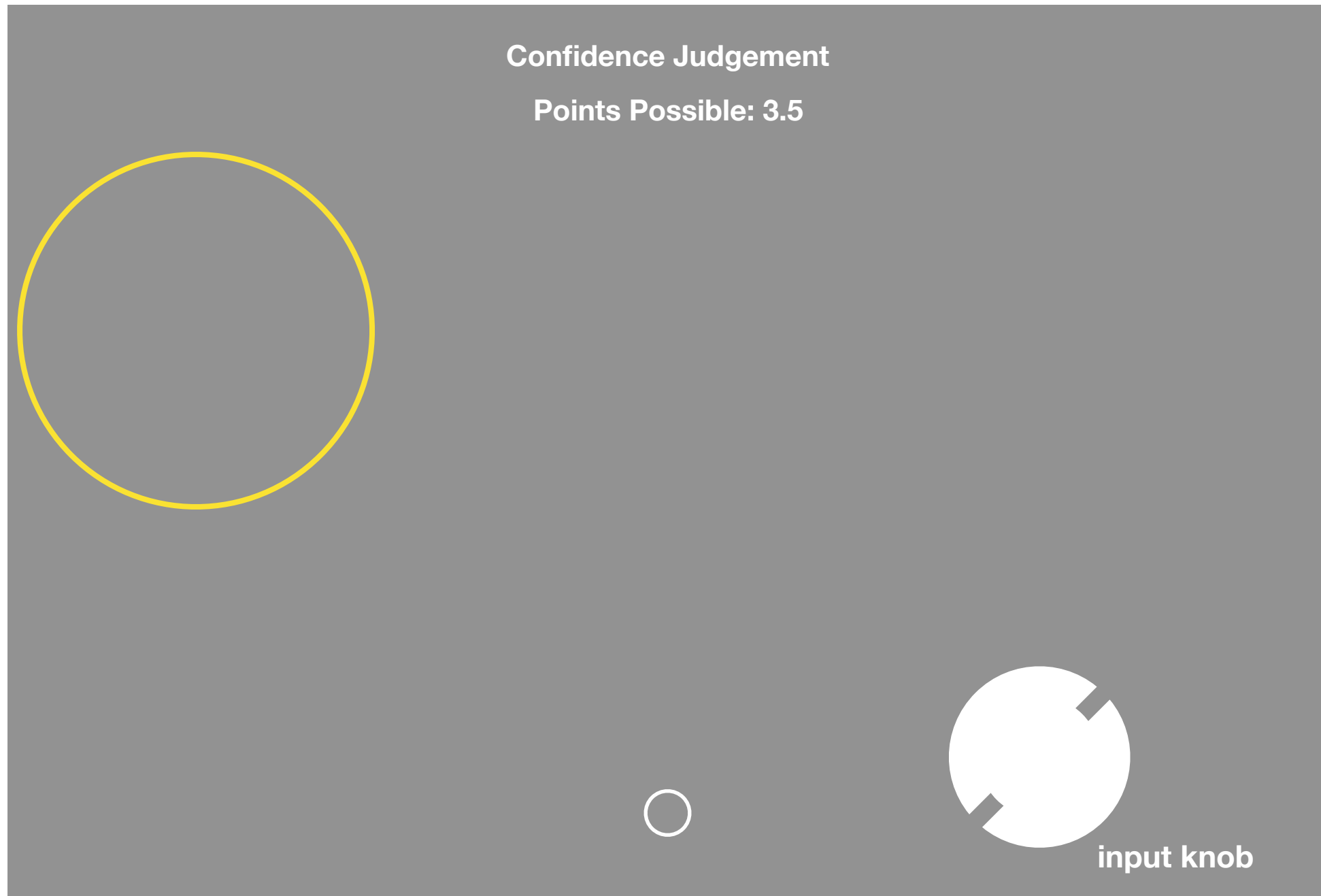
Experimental Paradigm



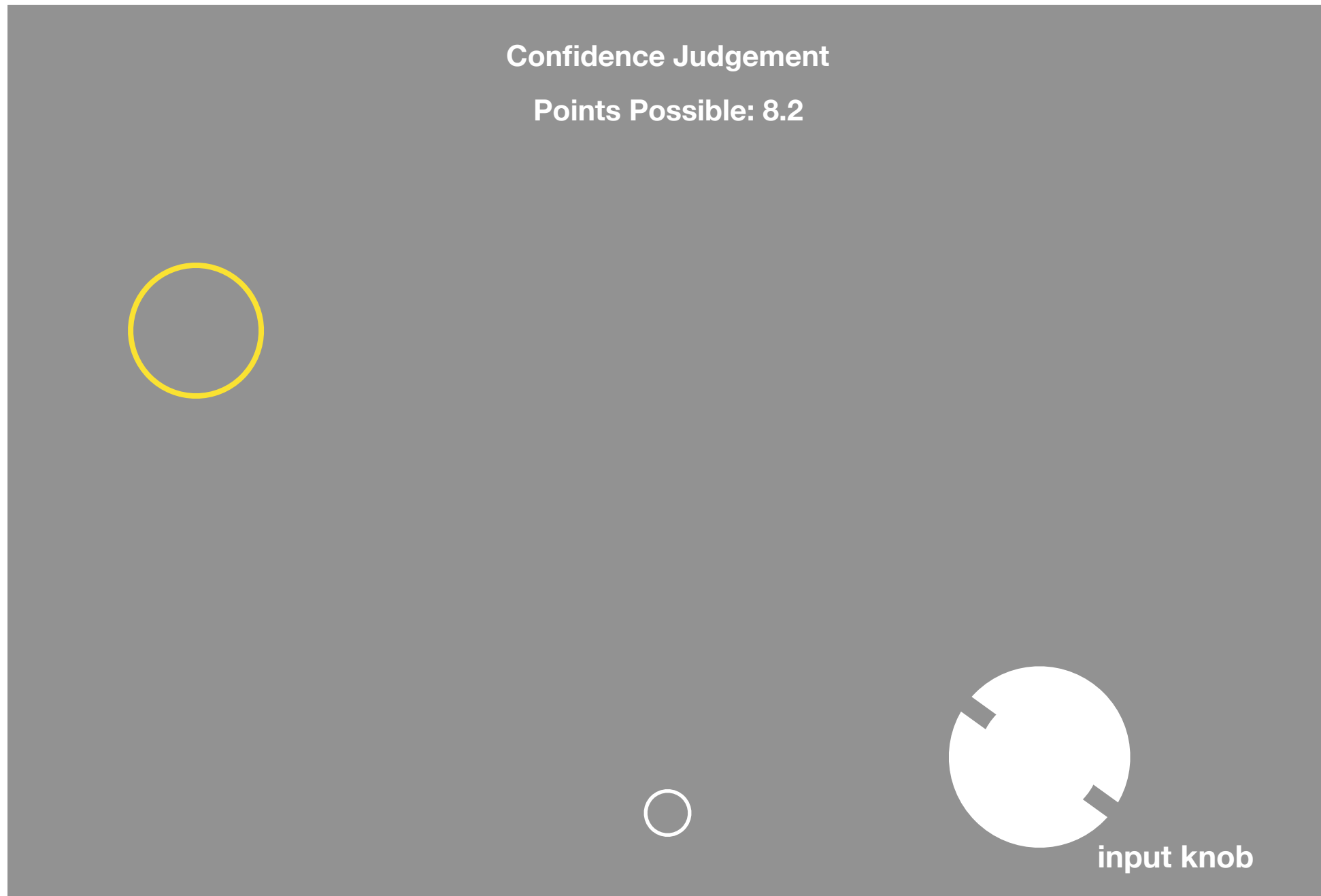
Experimental Paradigm



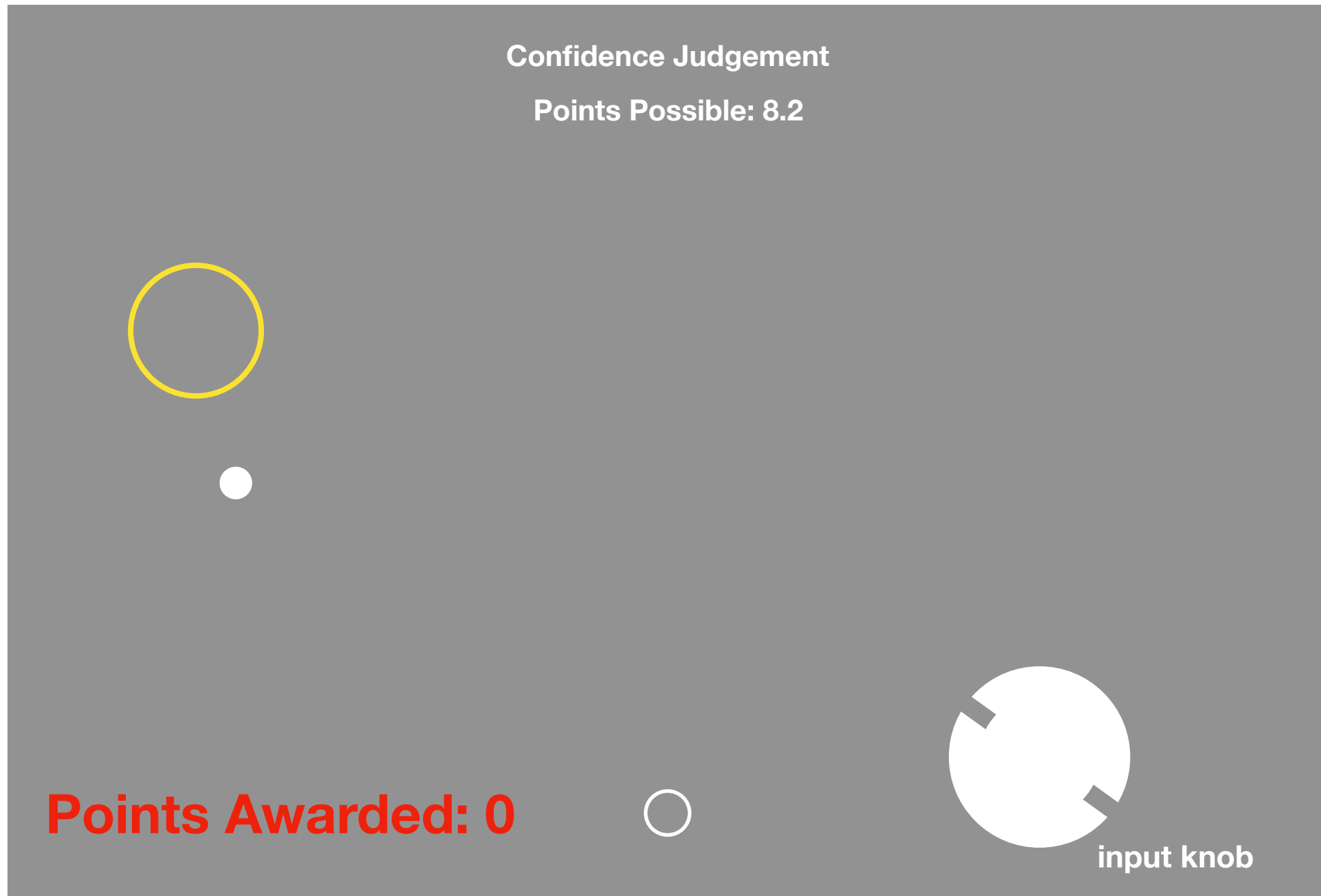
Experimental Paradigm



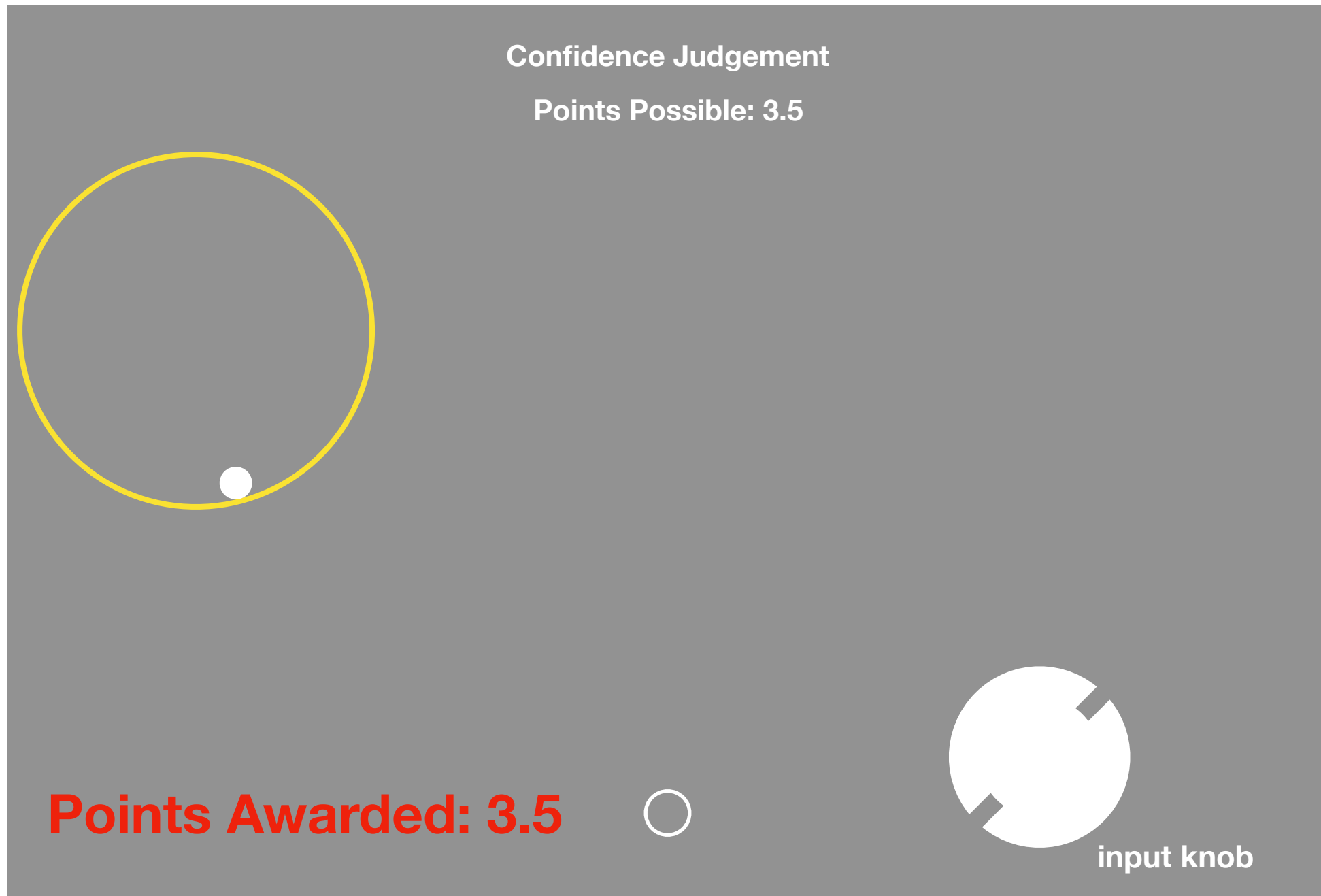
Experimental Paradigm



Experimental Paradigm

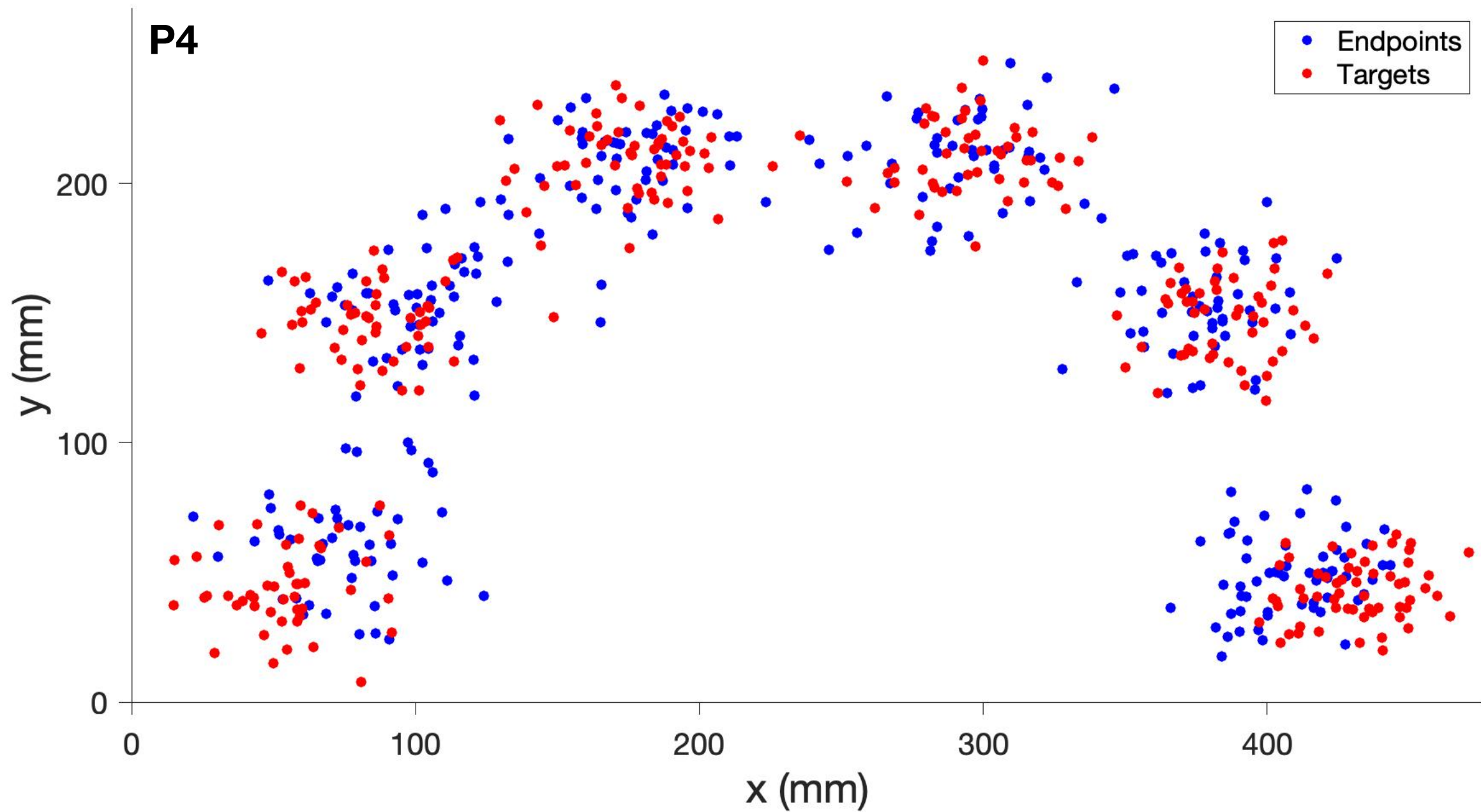


Experimental Paradigm

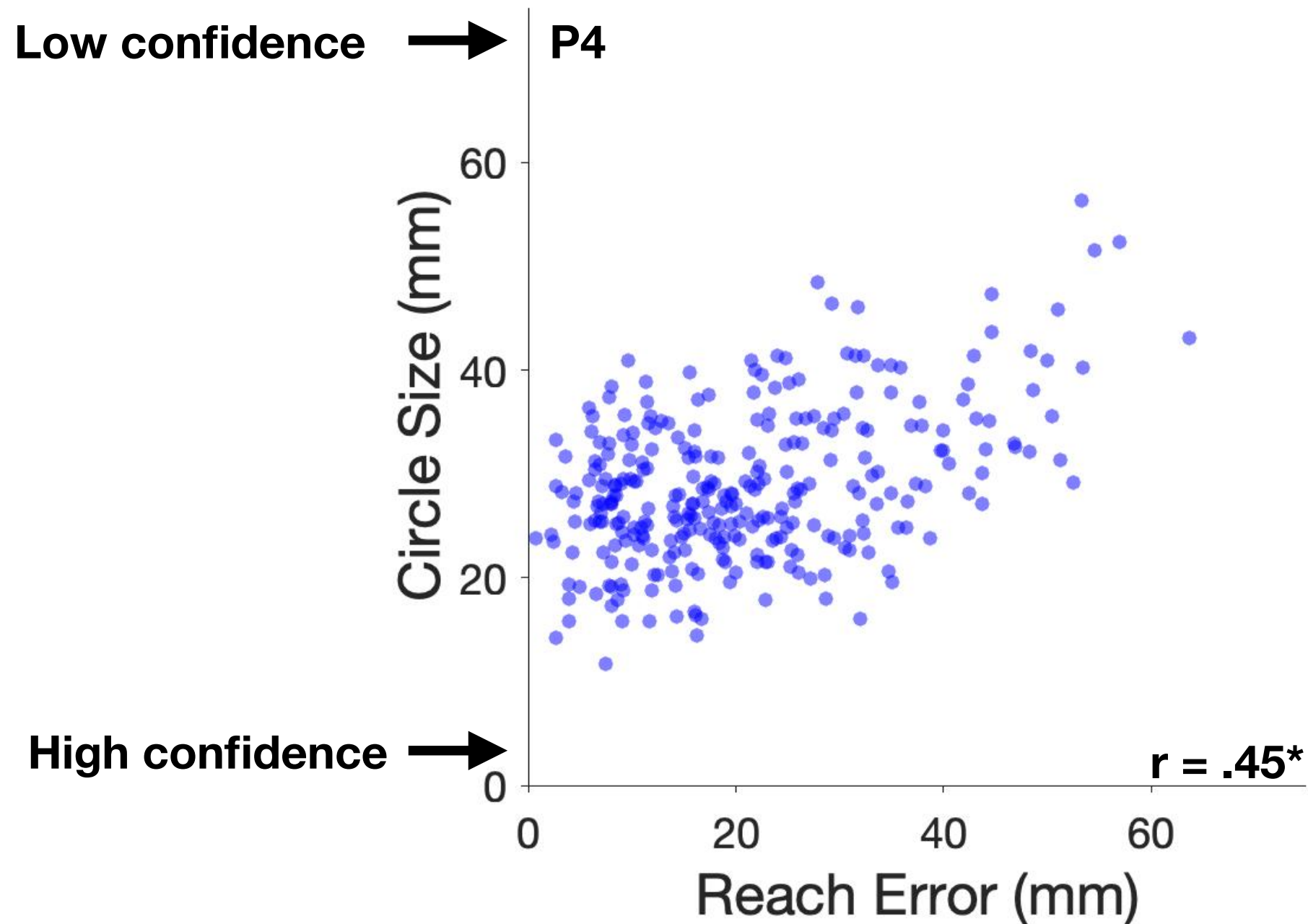


Behavioral Results

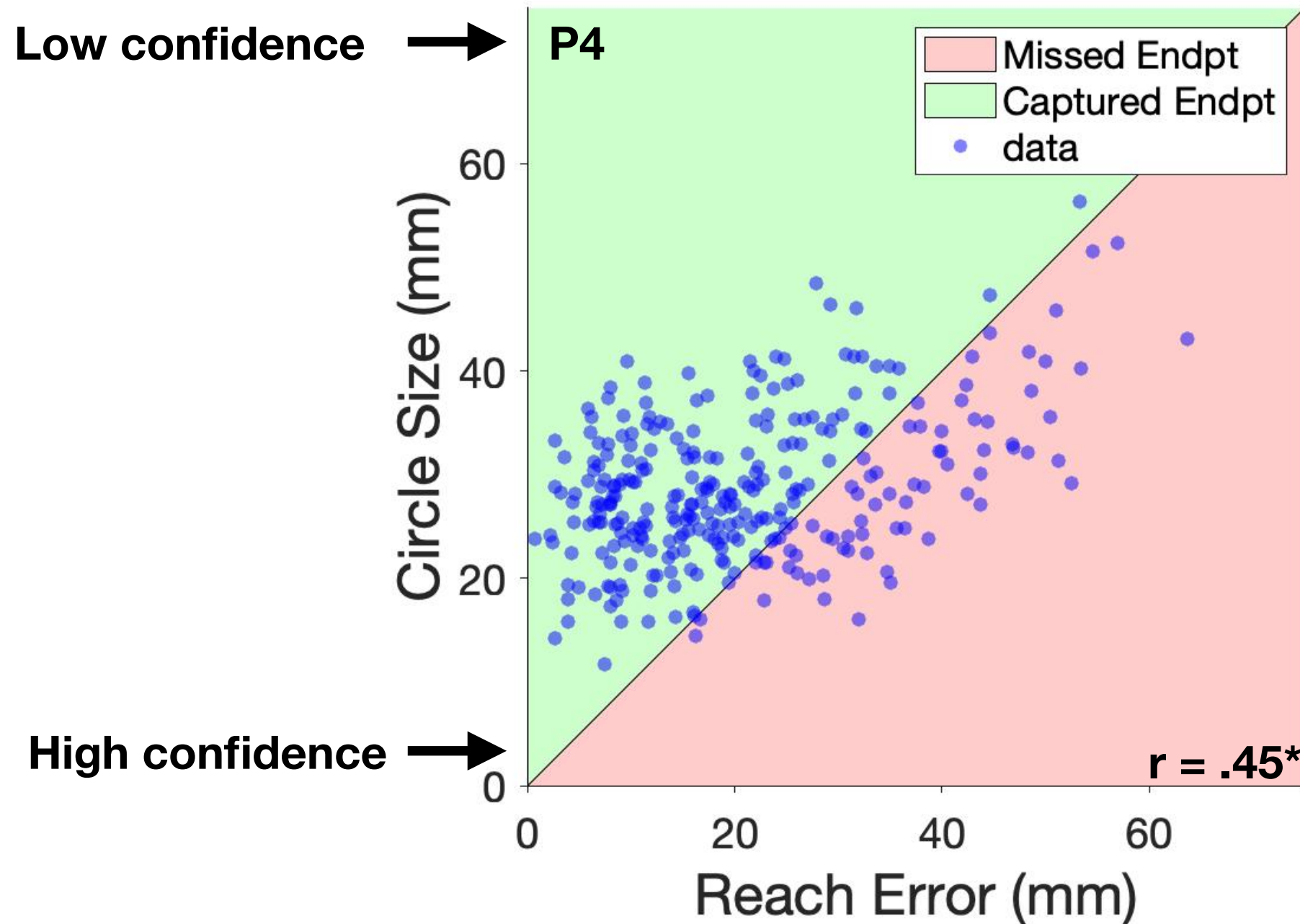
Endpoints on Tablet



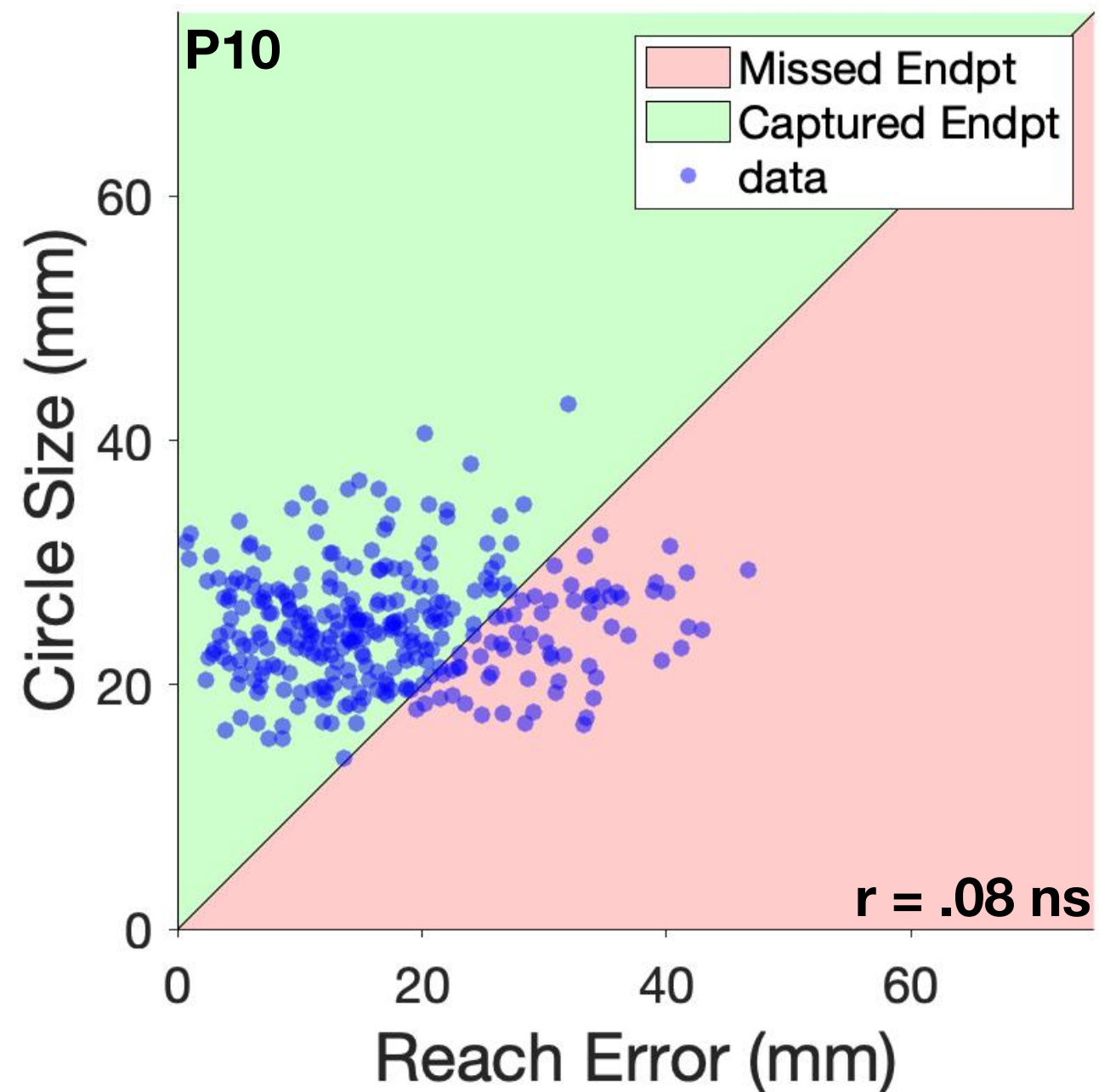
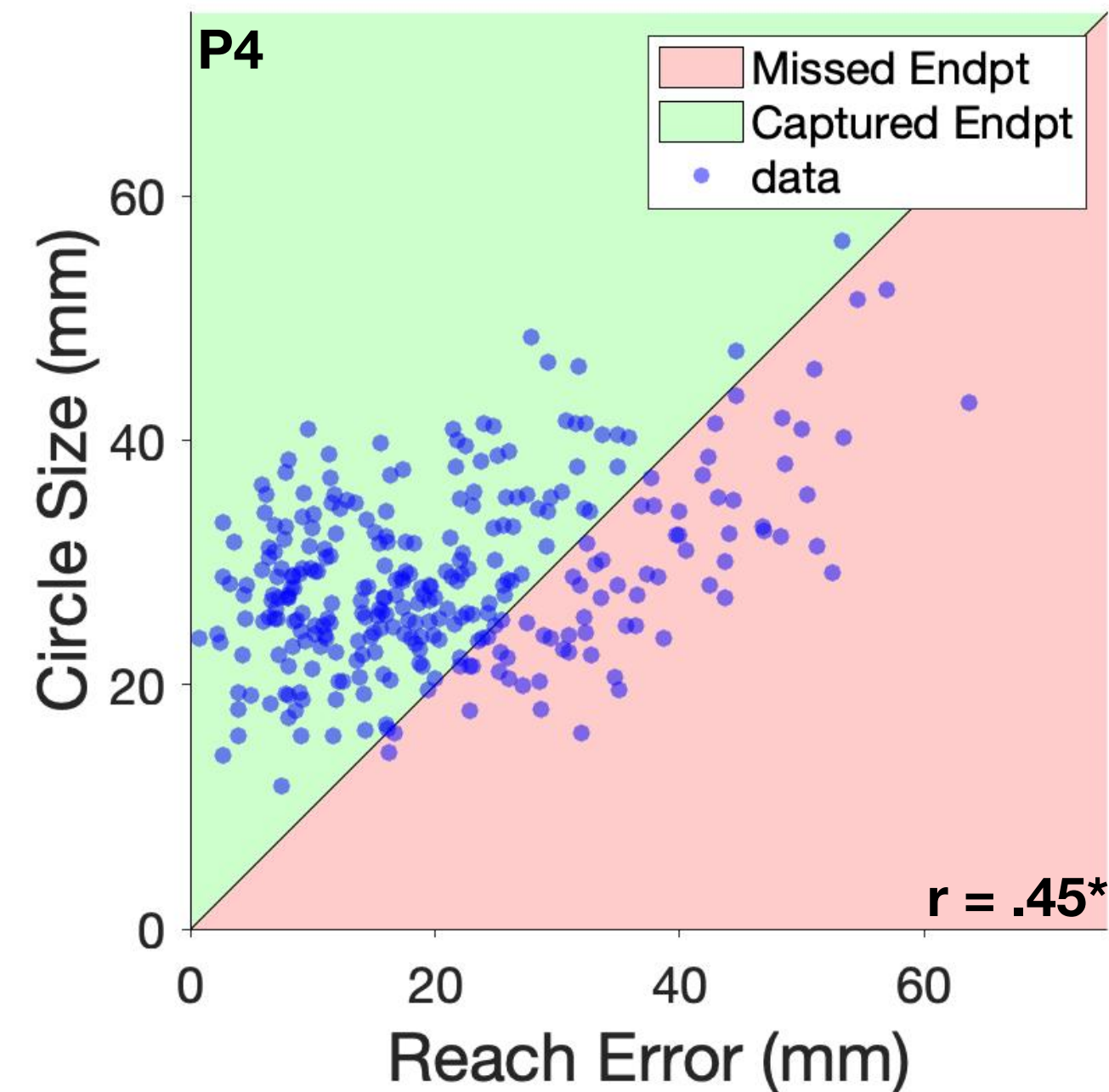
Confidence Performance Correlation



Confidence Performance Correlation

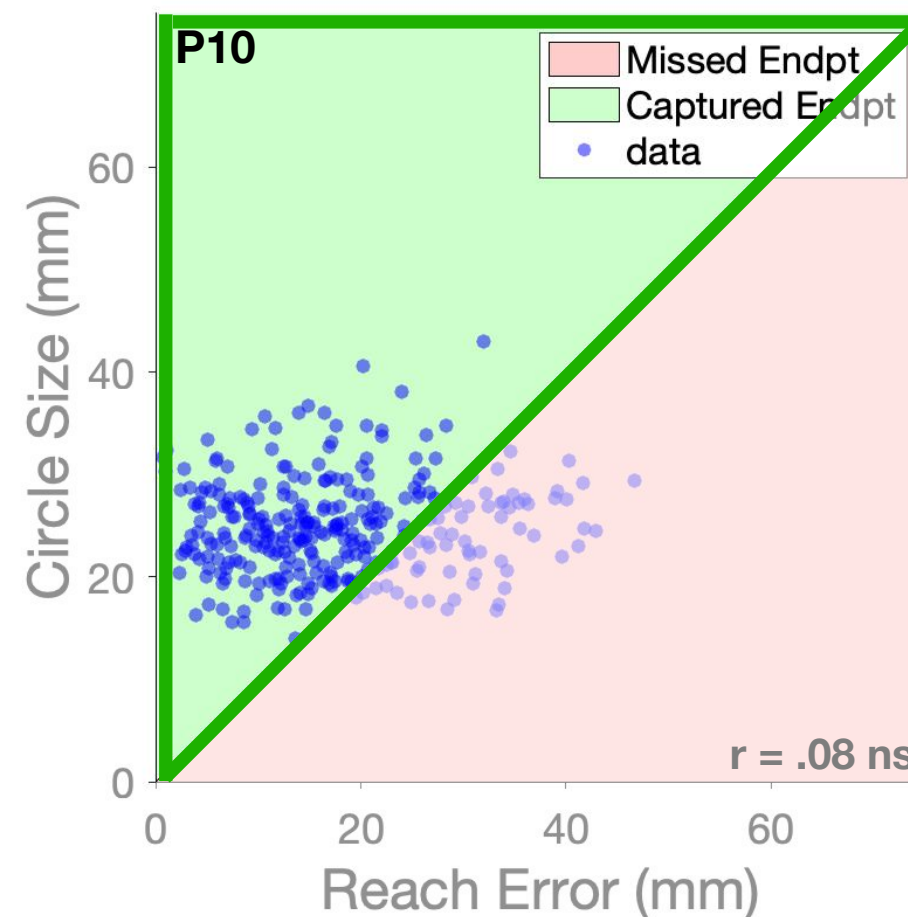
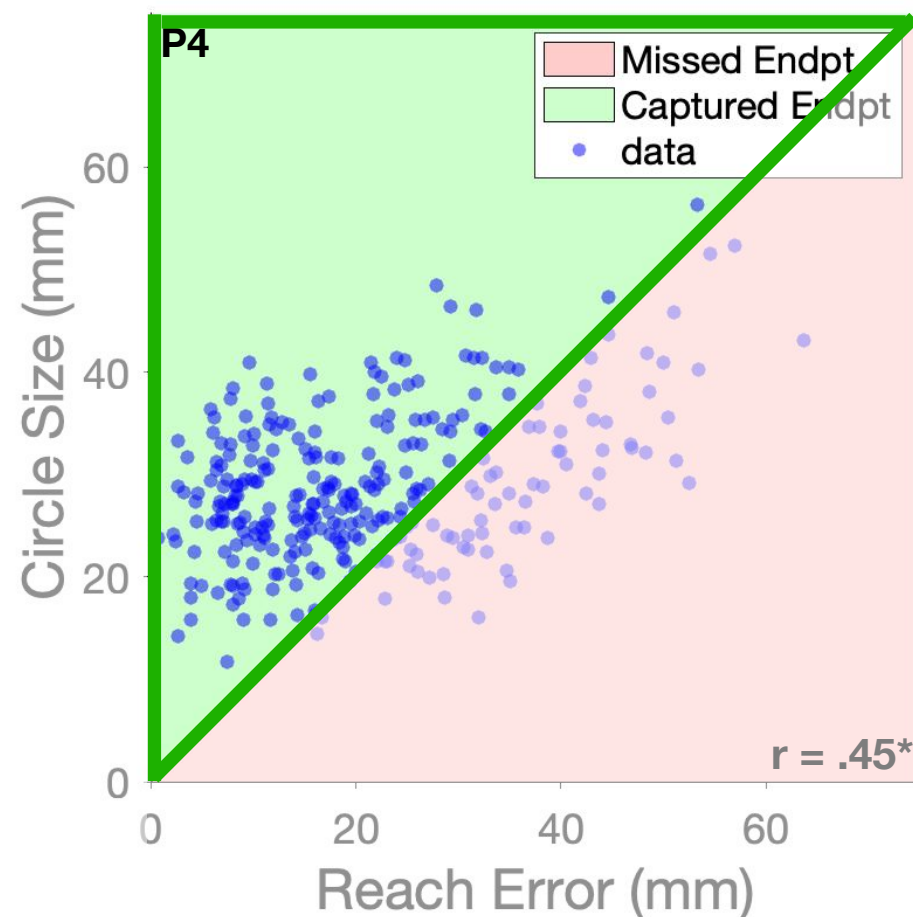


Confidence Performance Correlation



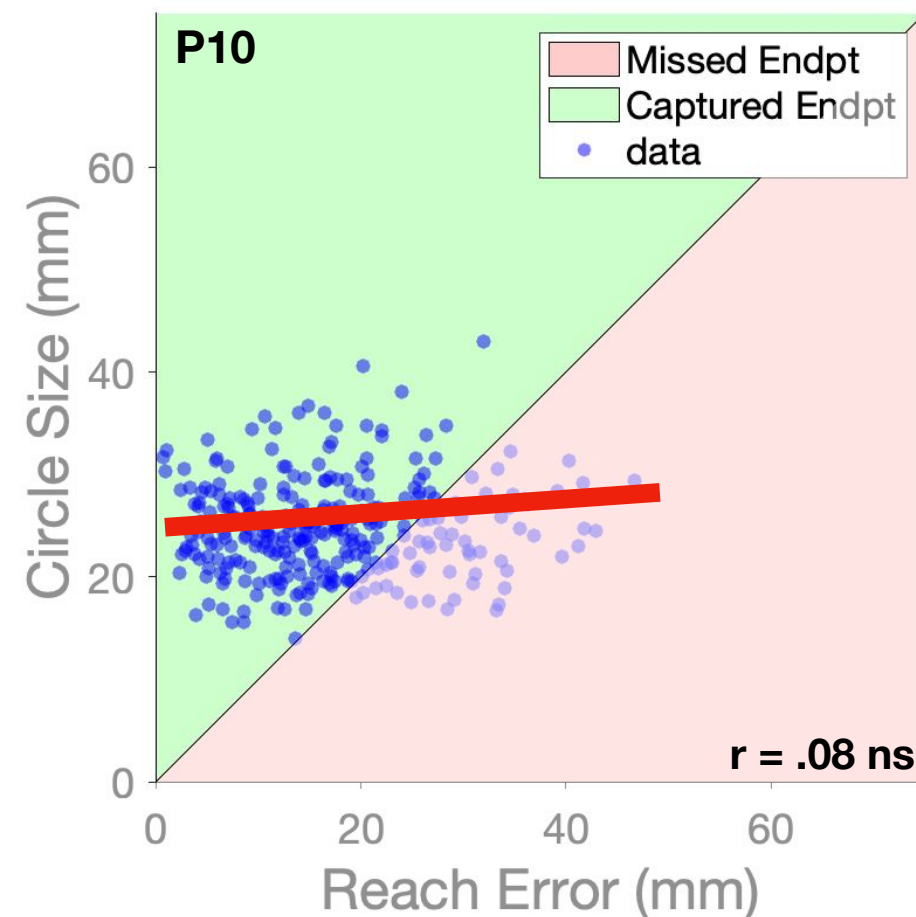
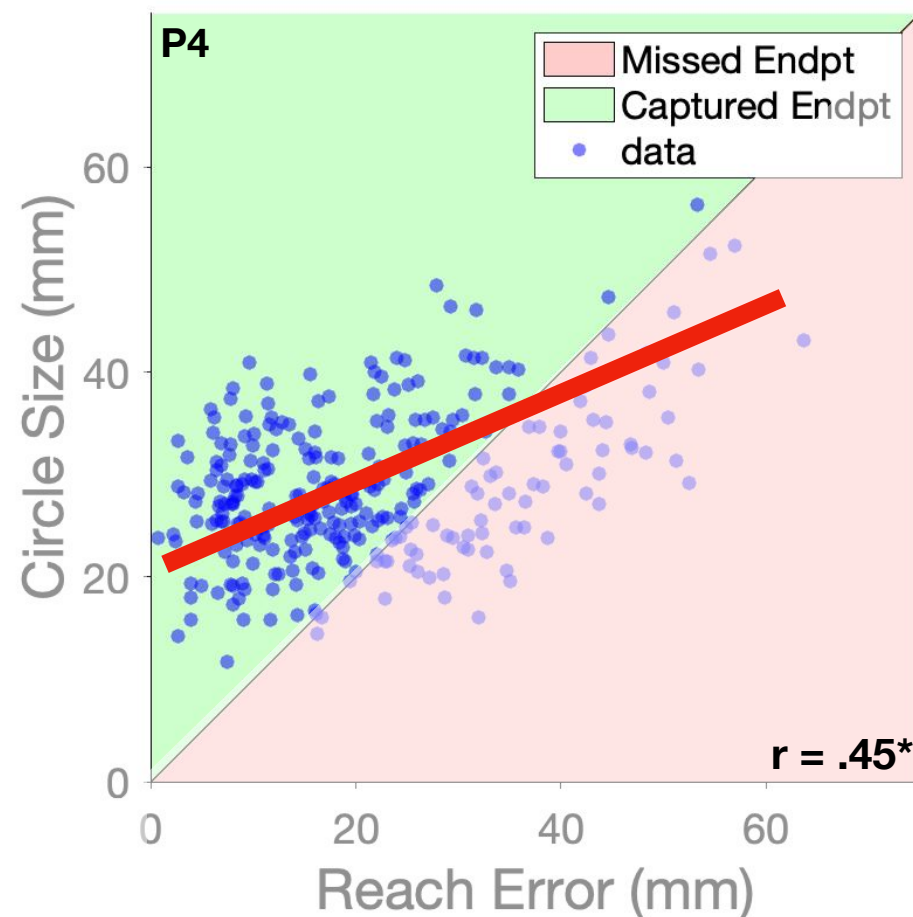
Confidence Performance Correlation

- Participants capture the majority of their endpoints to successfully earn points



Confidence Performance Correlation

- Participants capture the majority of their endpoints to successfully earn points
- Some participants' confidence reports significantly correlated with performance while other's are not



MODEL PARAMETERS

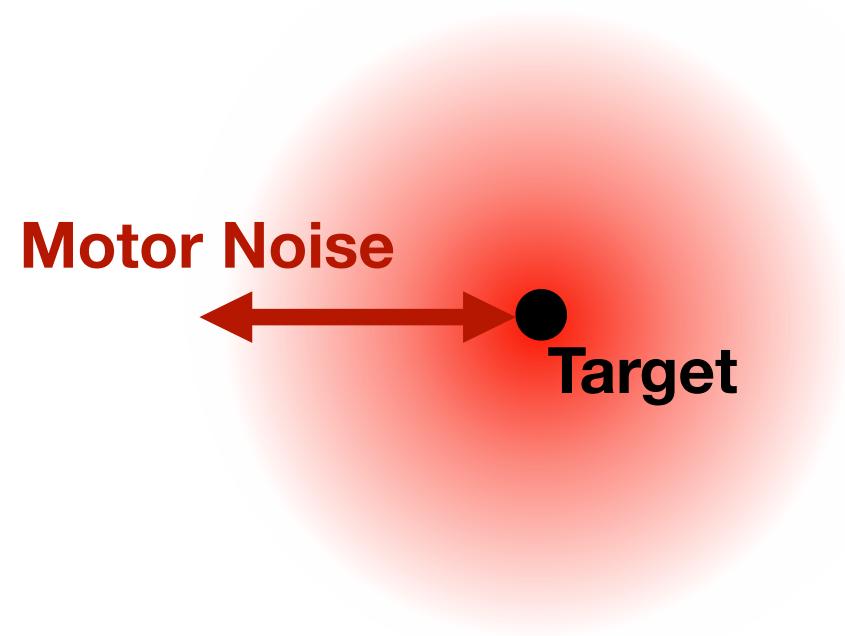
MODELS

	Prospective Cues	Retrospective Cues	Setting Noise
Ideal Observer	✓	✓	✓
Retrospective Observer	✗	✓	✓
Prospective Observer	✓	✗	✓

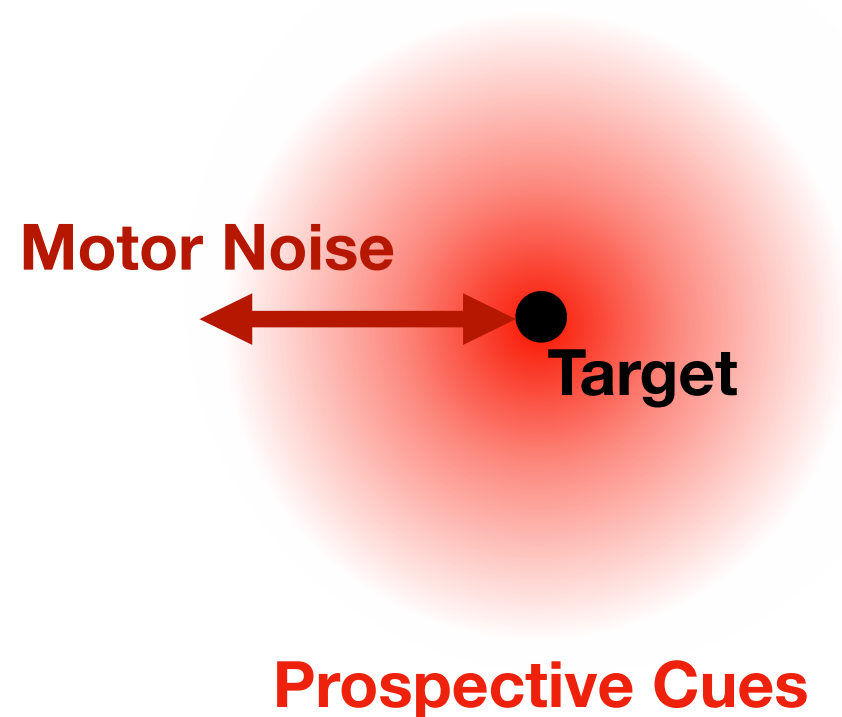
Ideal Observer Model

● Target

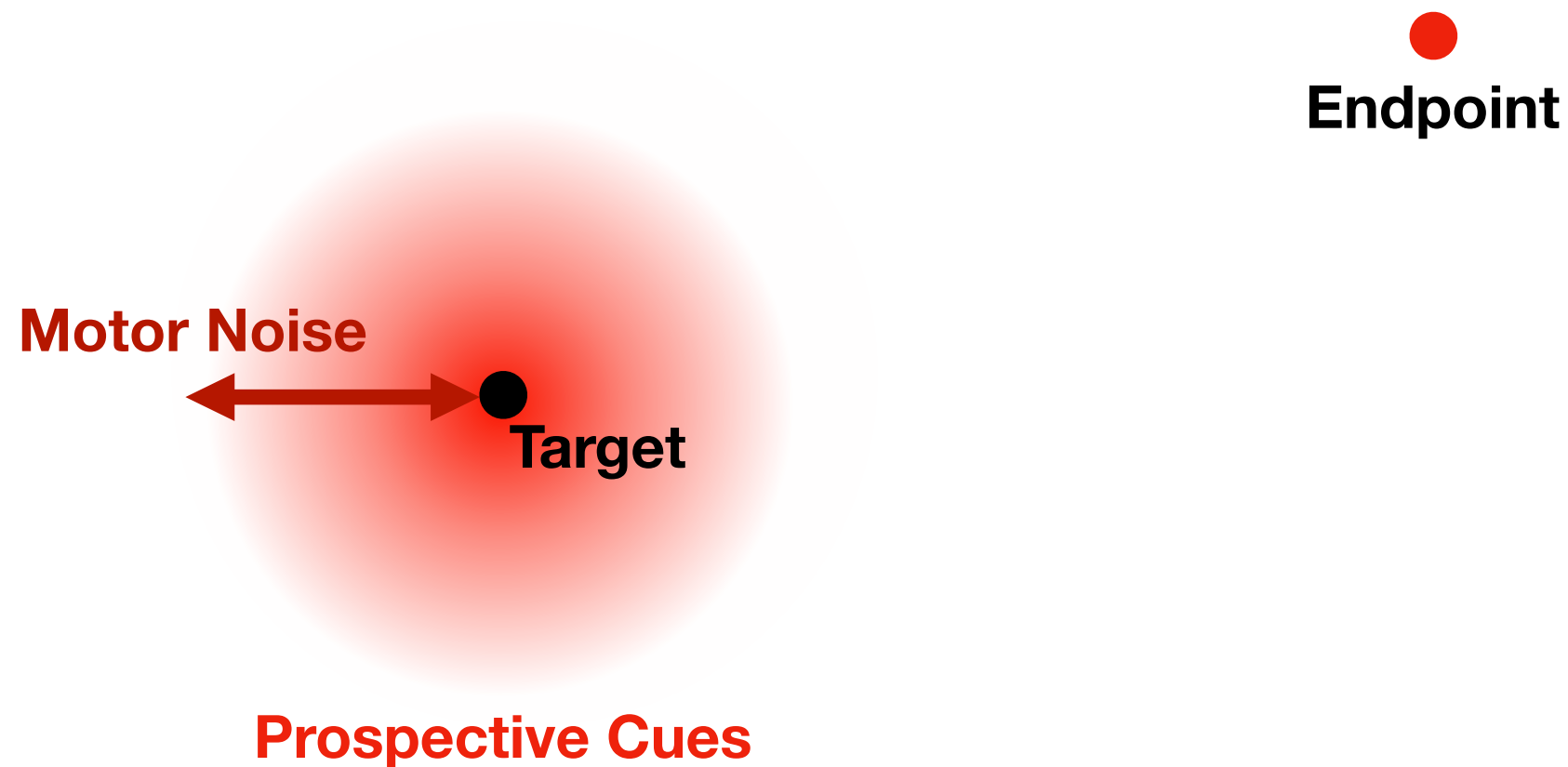
Ideal Observer Model



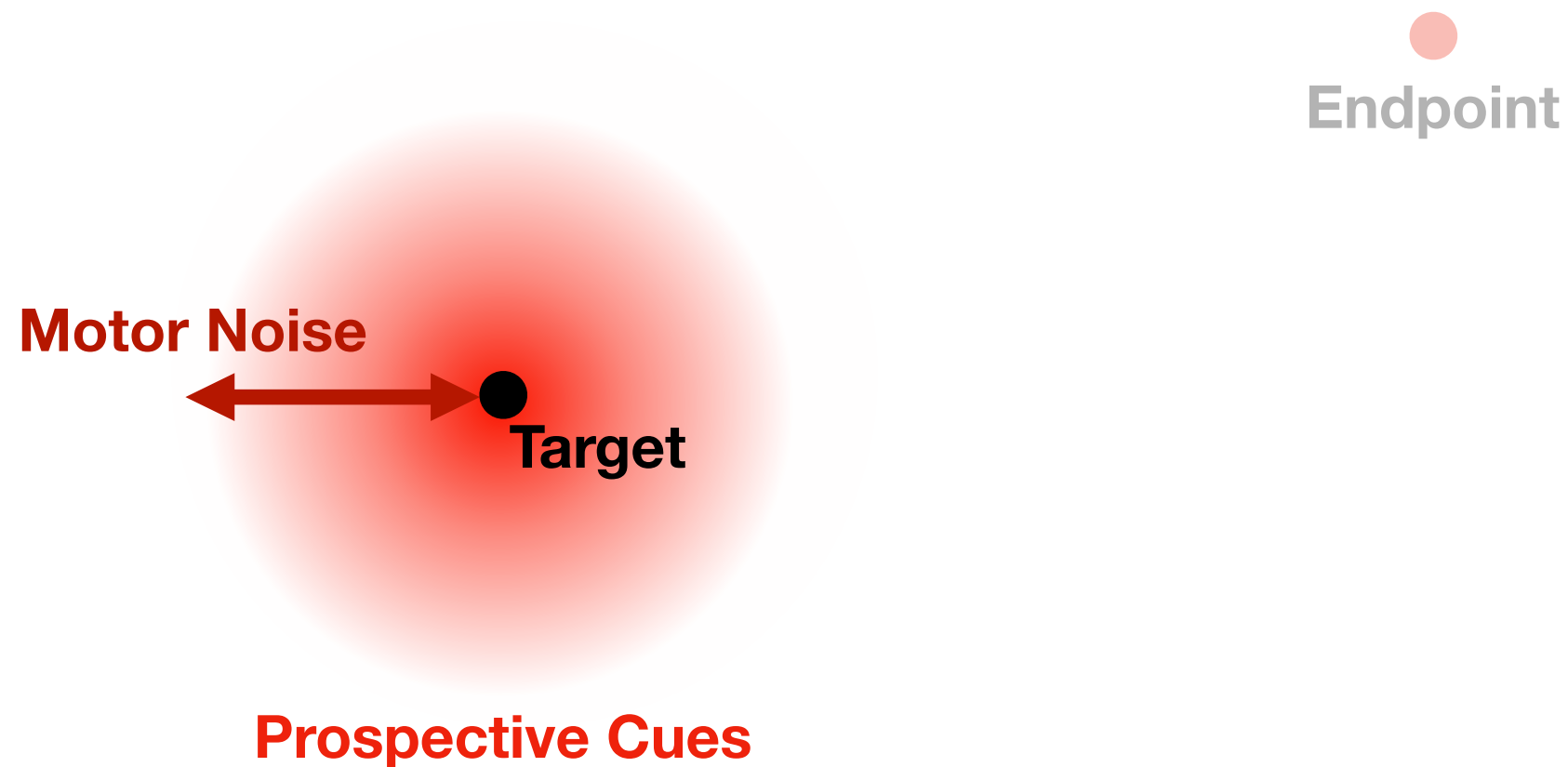
Ideal Observer Model



Ideal Observer Model



Ideal Observer Model



Ideal Observer Model

Sensed Location



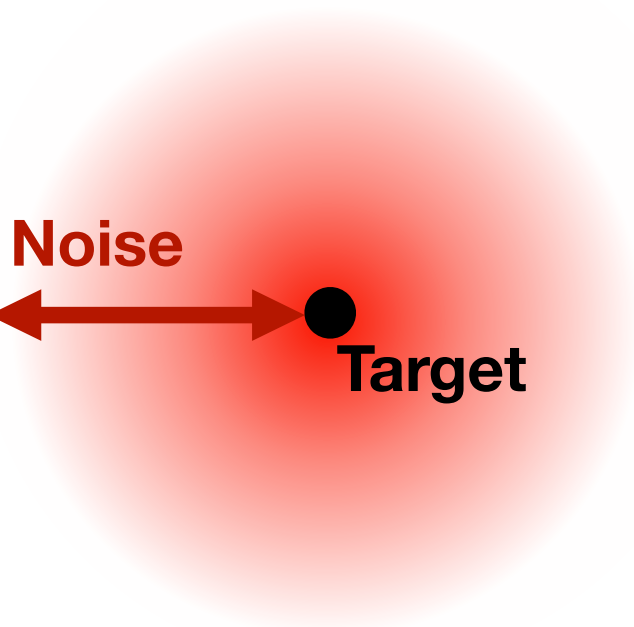
Endpoint

Motor Noise

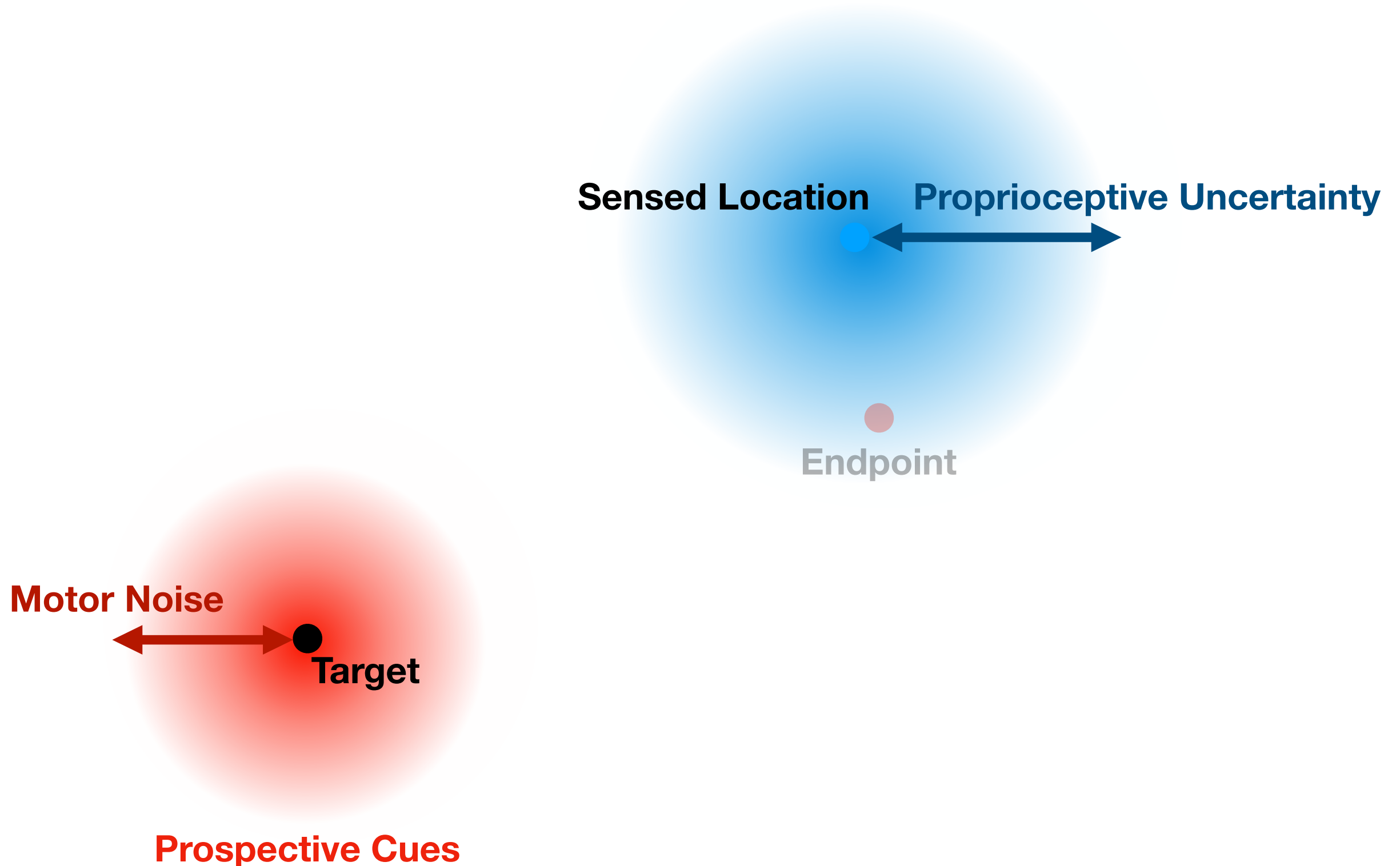


Target

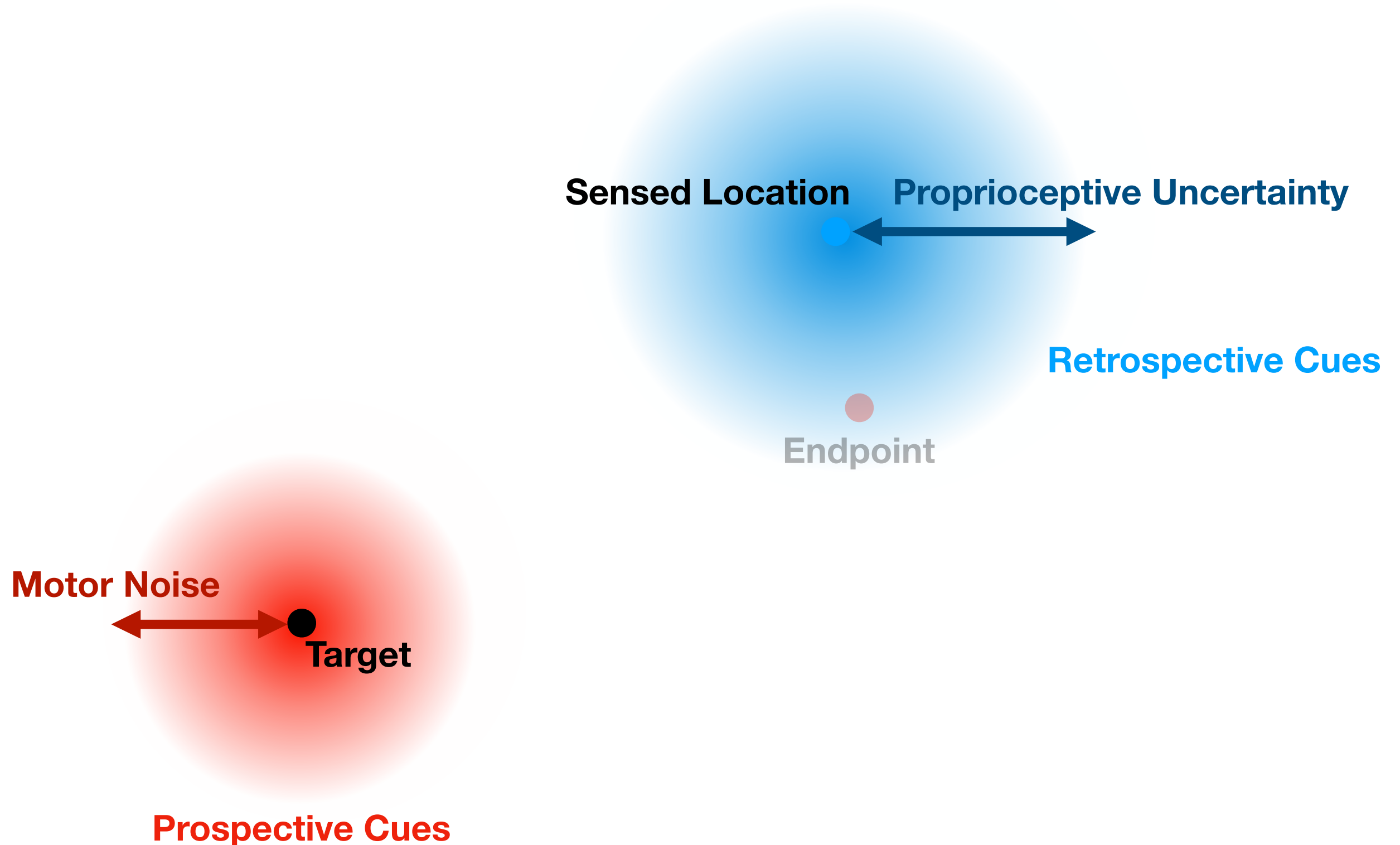
Prospective Cues



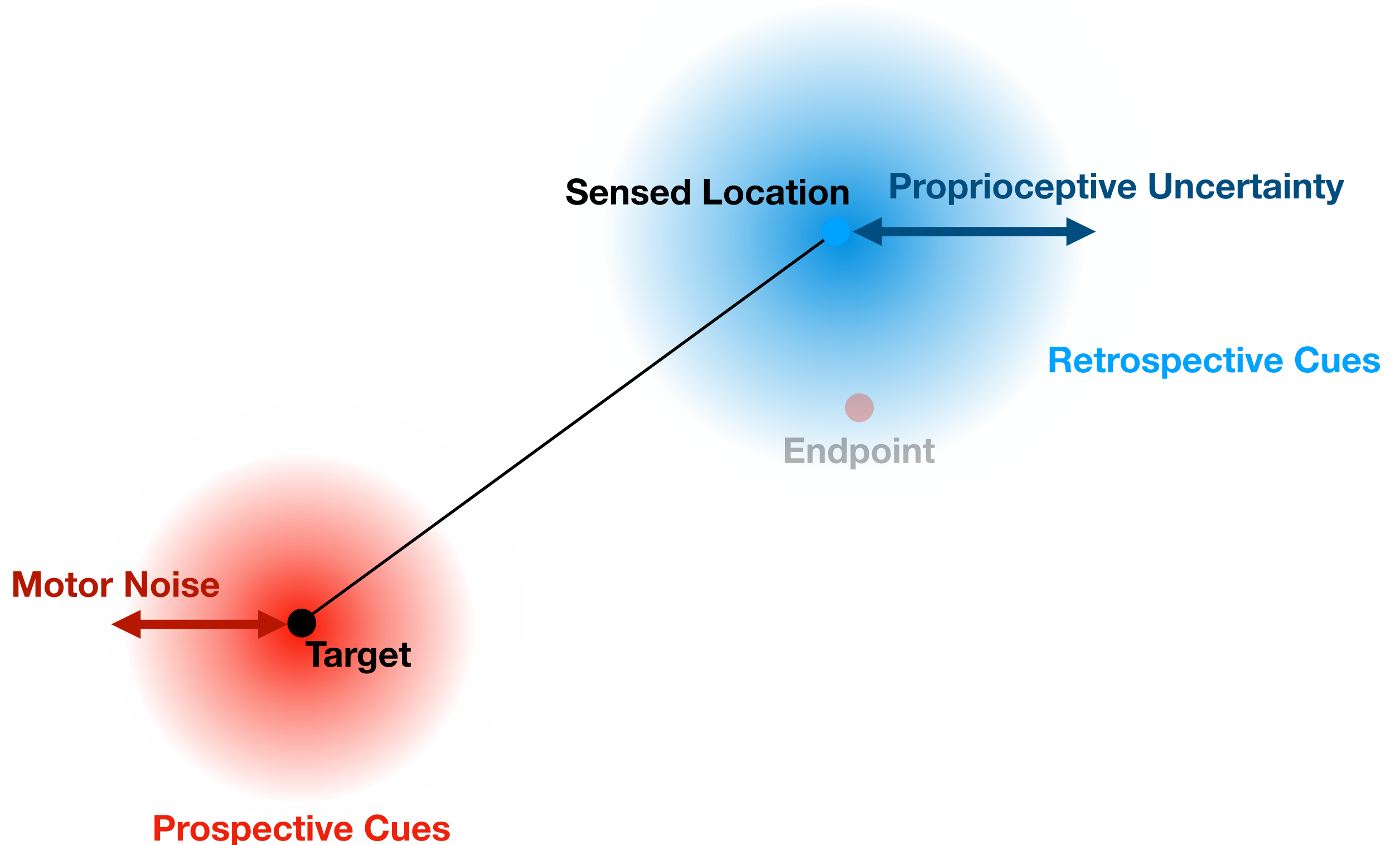
Ideal Observer Model



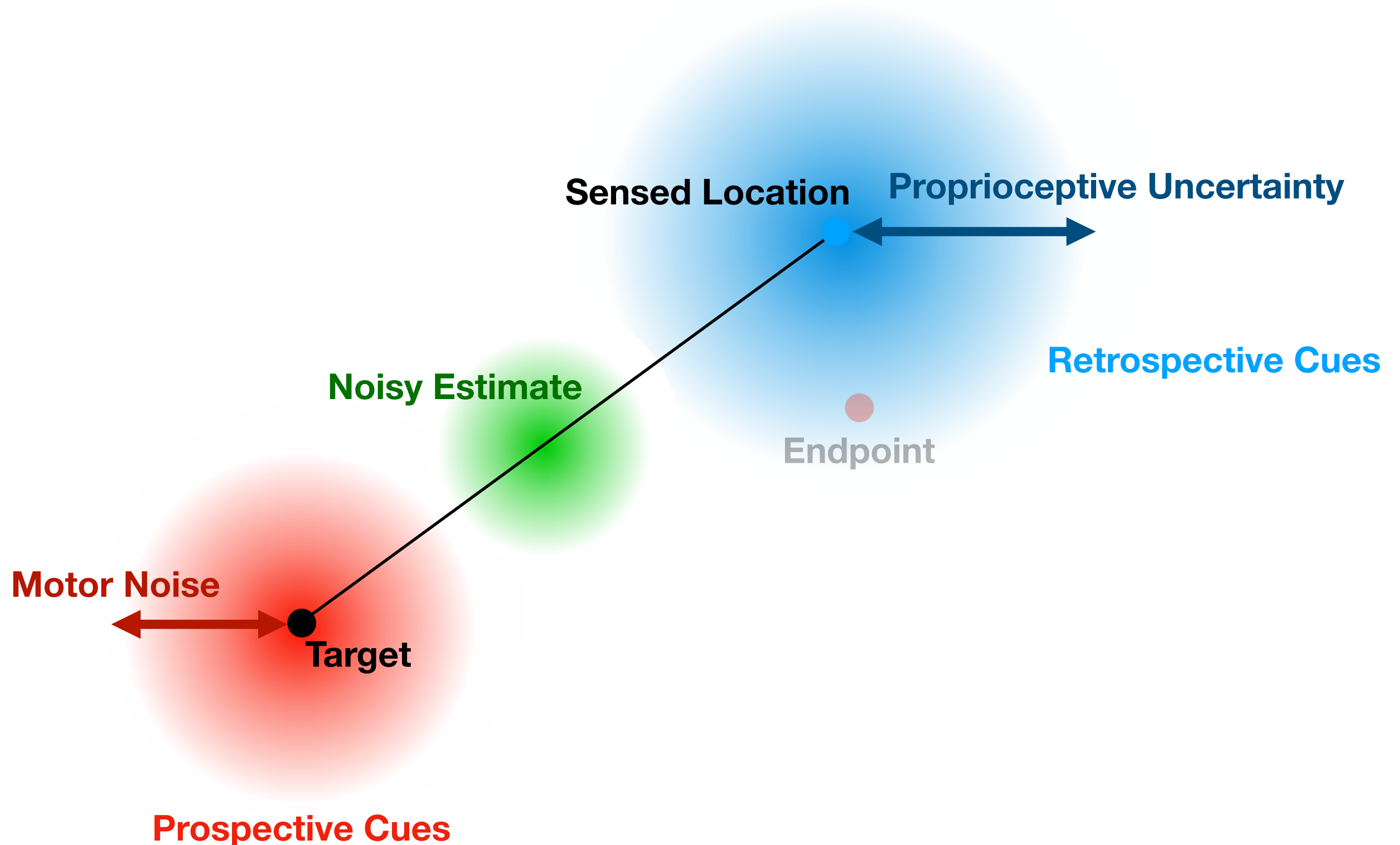
Ideal Observer Model



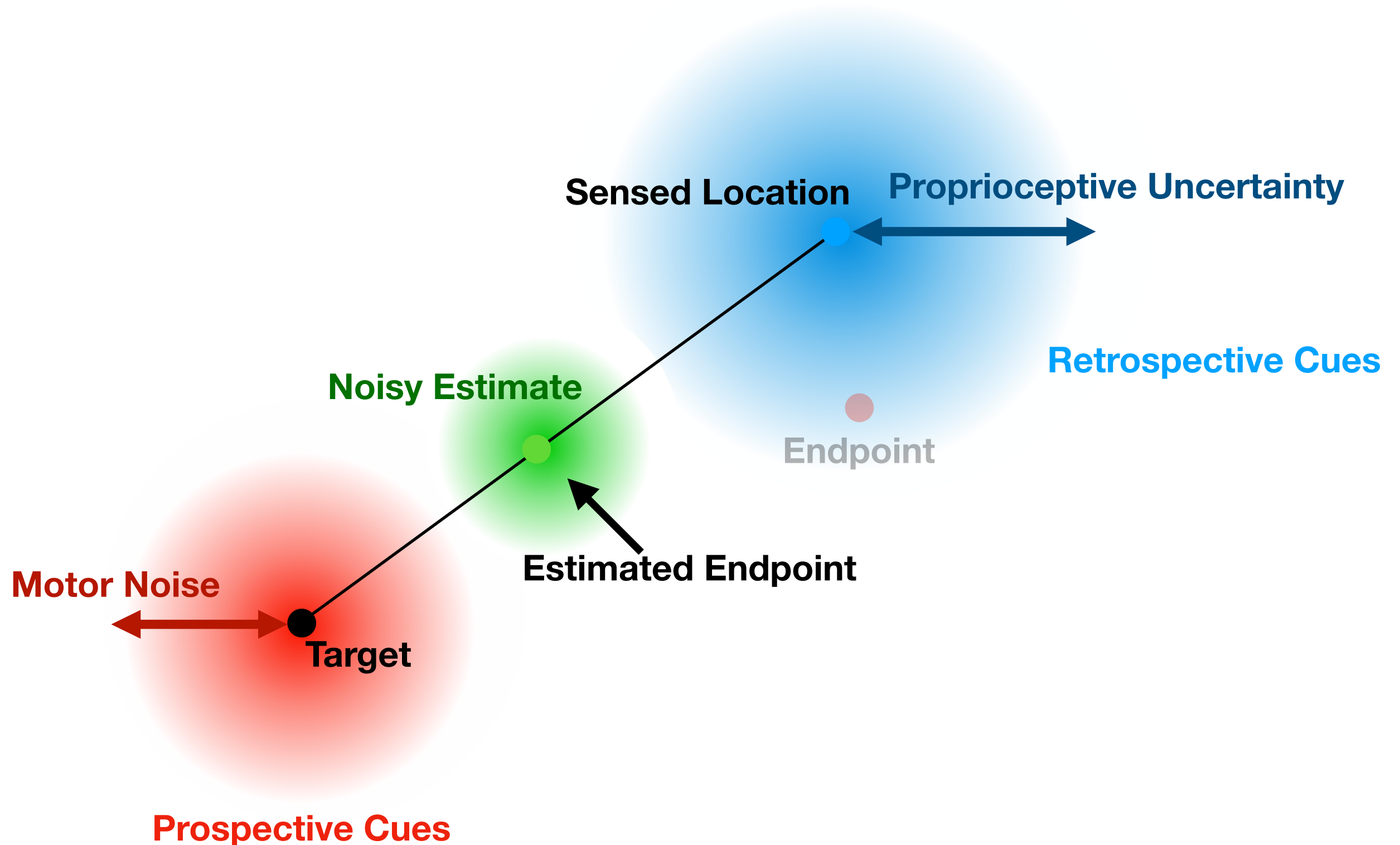
Ideal Observer Model



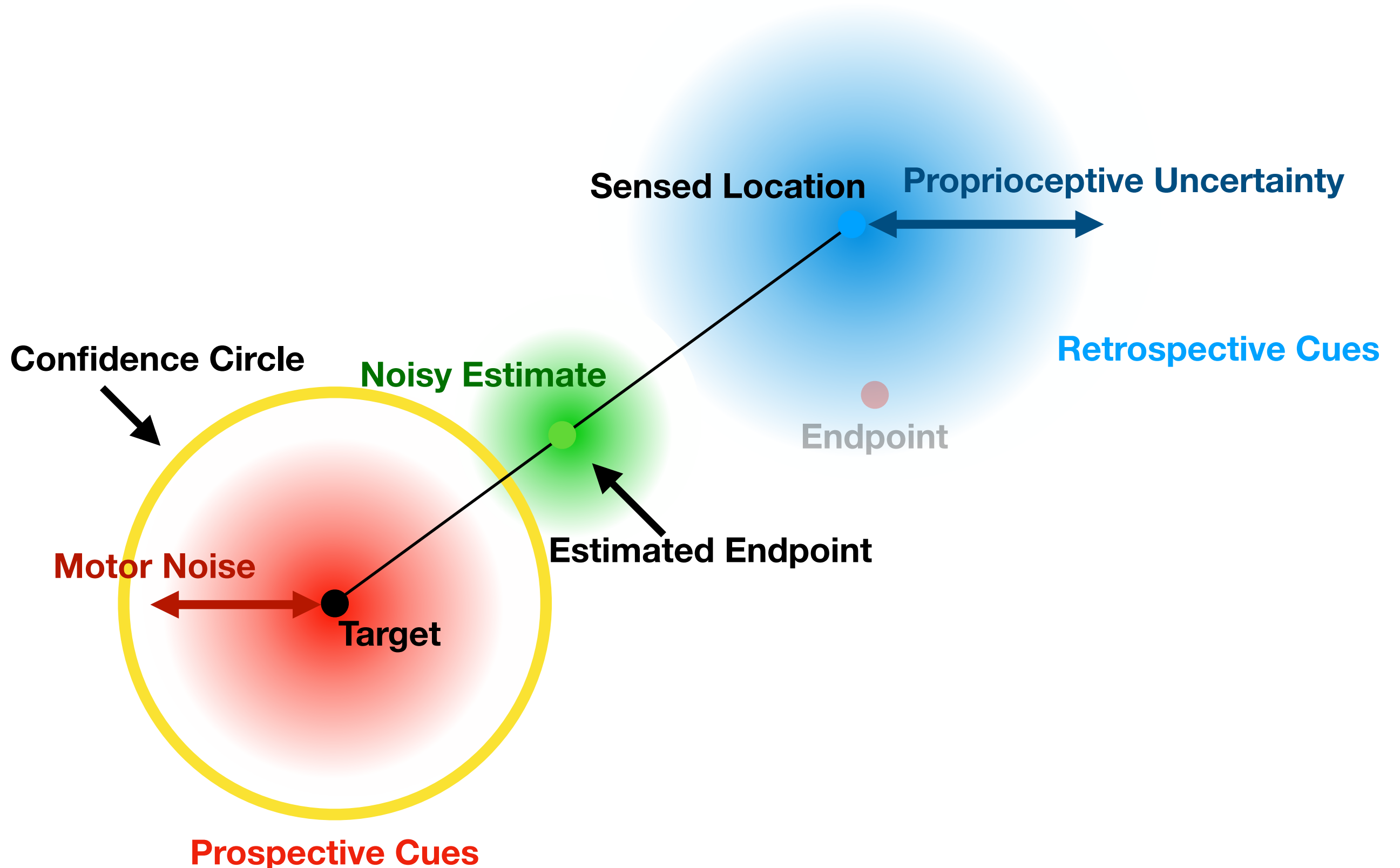
Ideal Observer Model



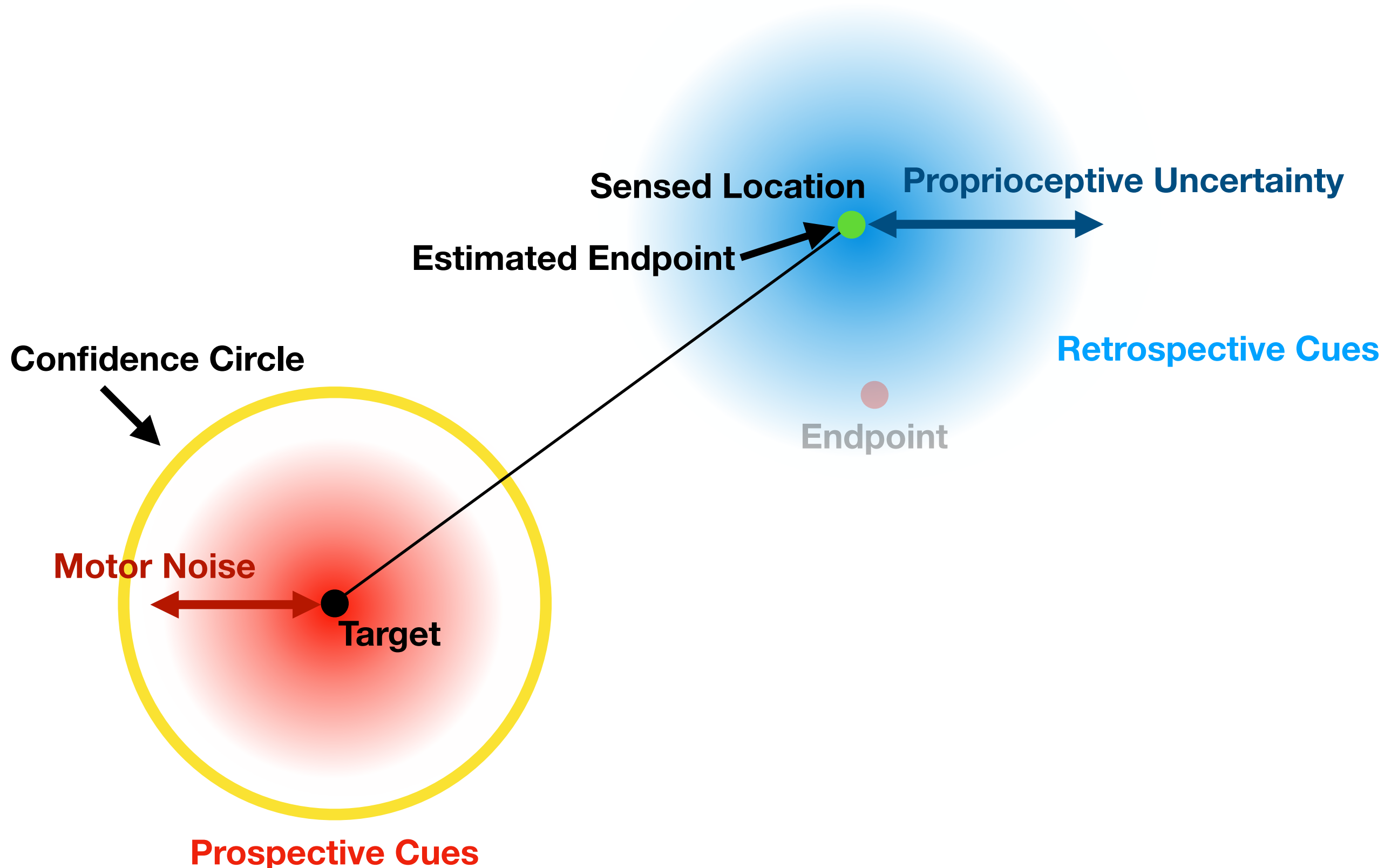
Ideal Observer Model



Ideal Observer Model



Retrospective Observer Model



Prospective Observer Model

Confidence Circle



Estimated Endpoint



Motor Noise

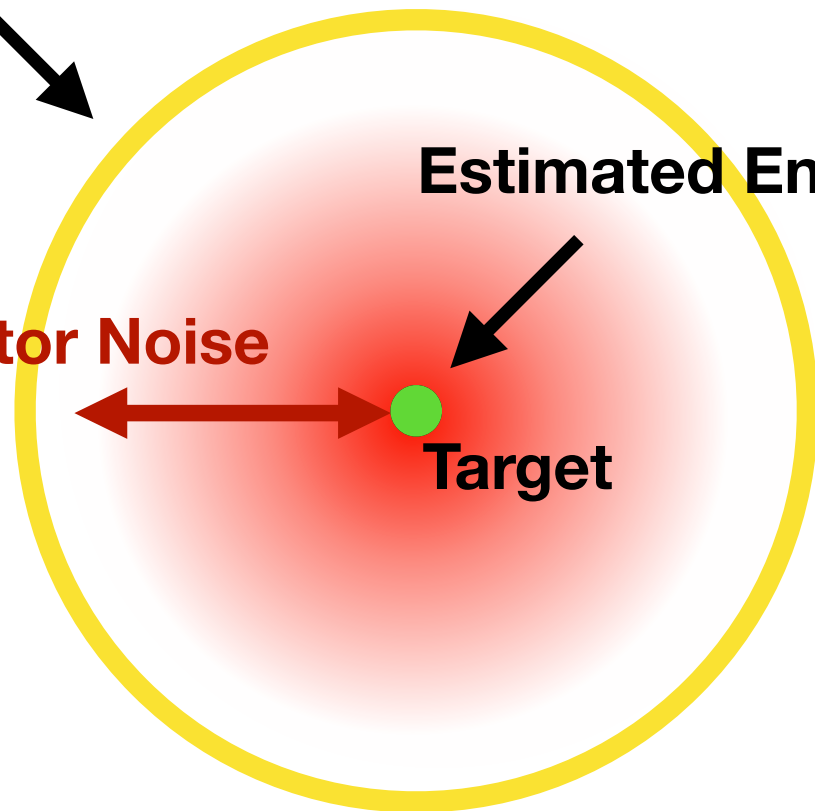


Target

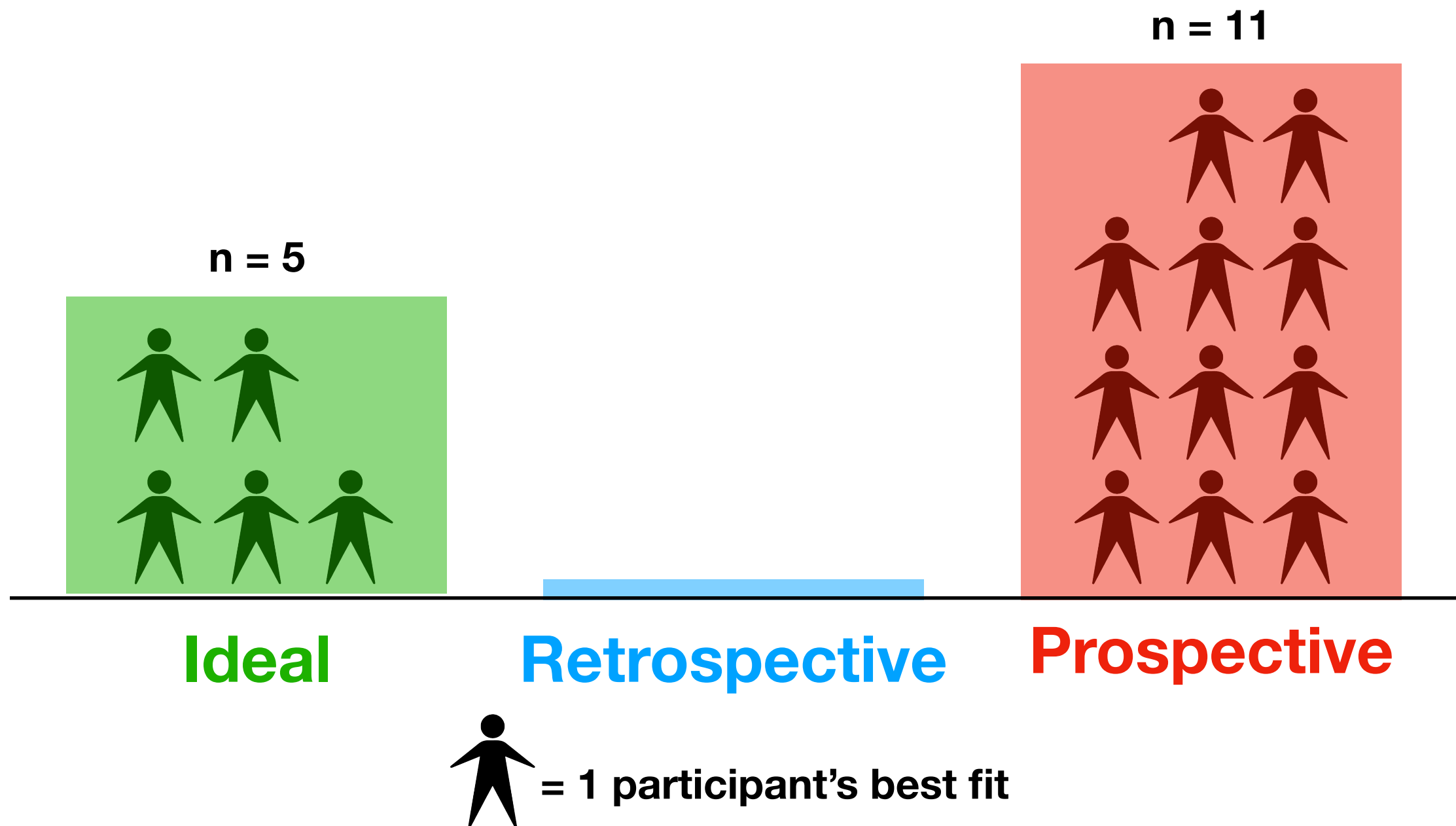
Endpoint



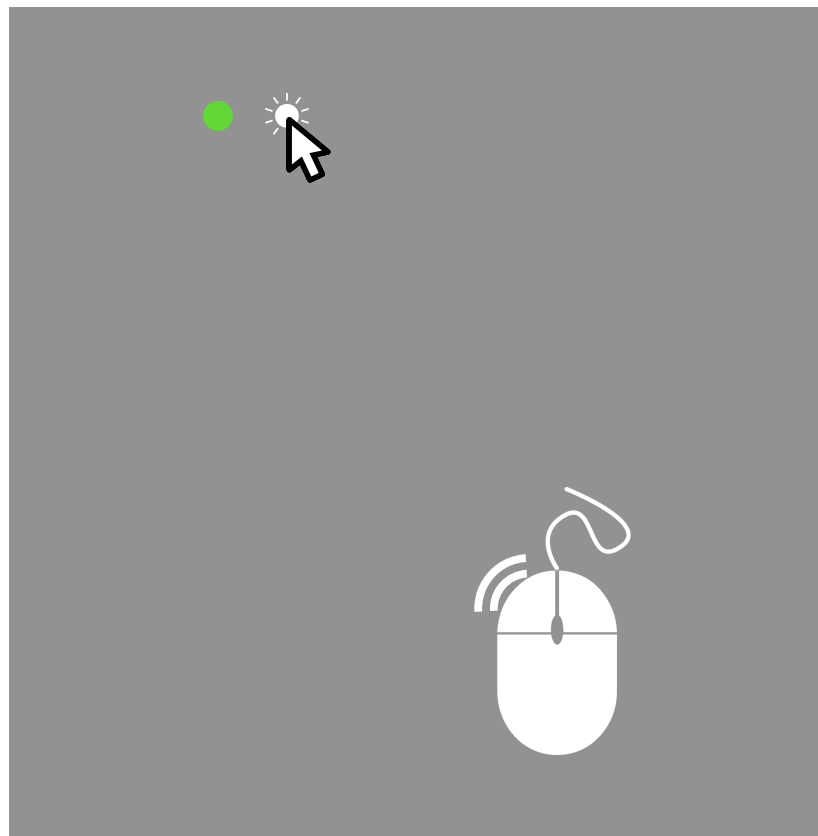
Prospective Cues



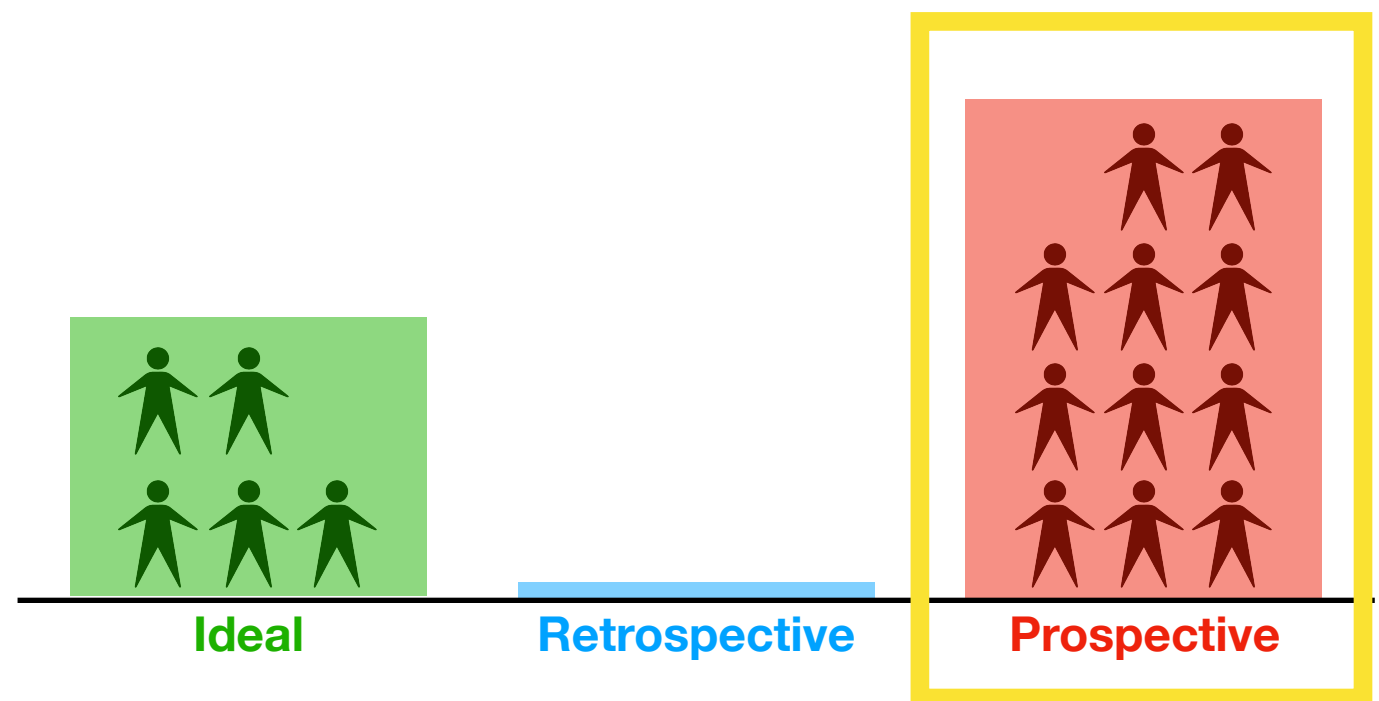
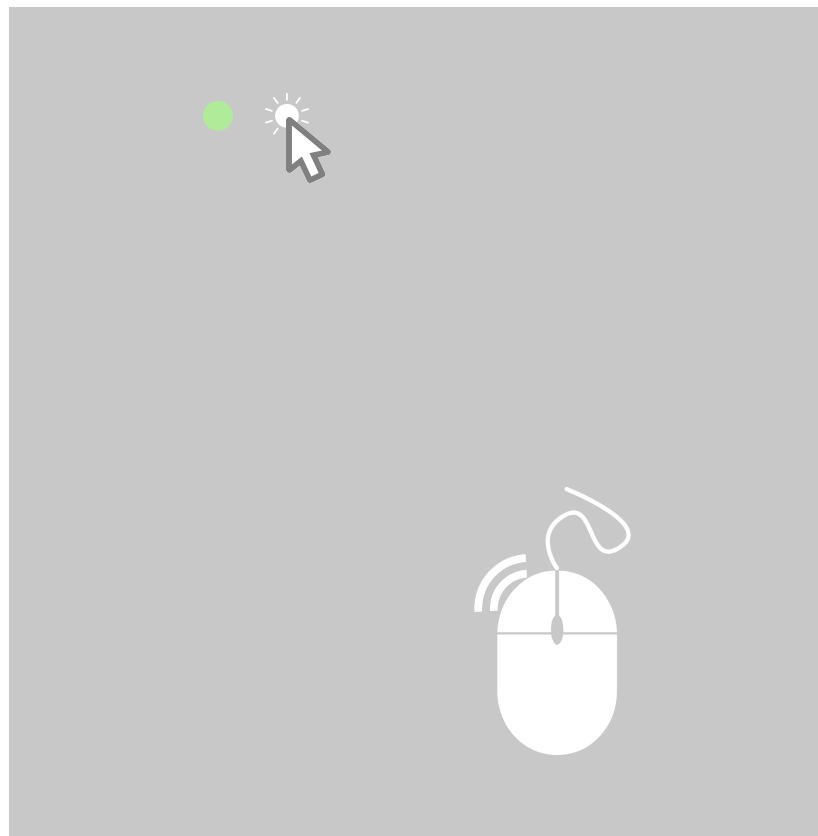
BIC Model Comparison



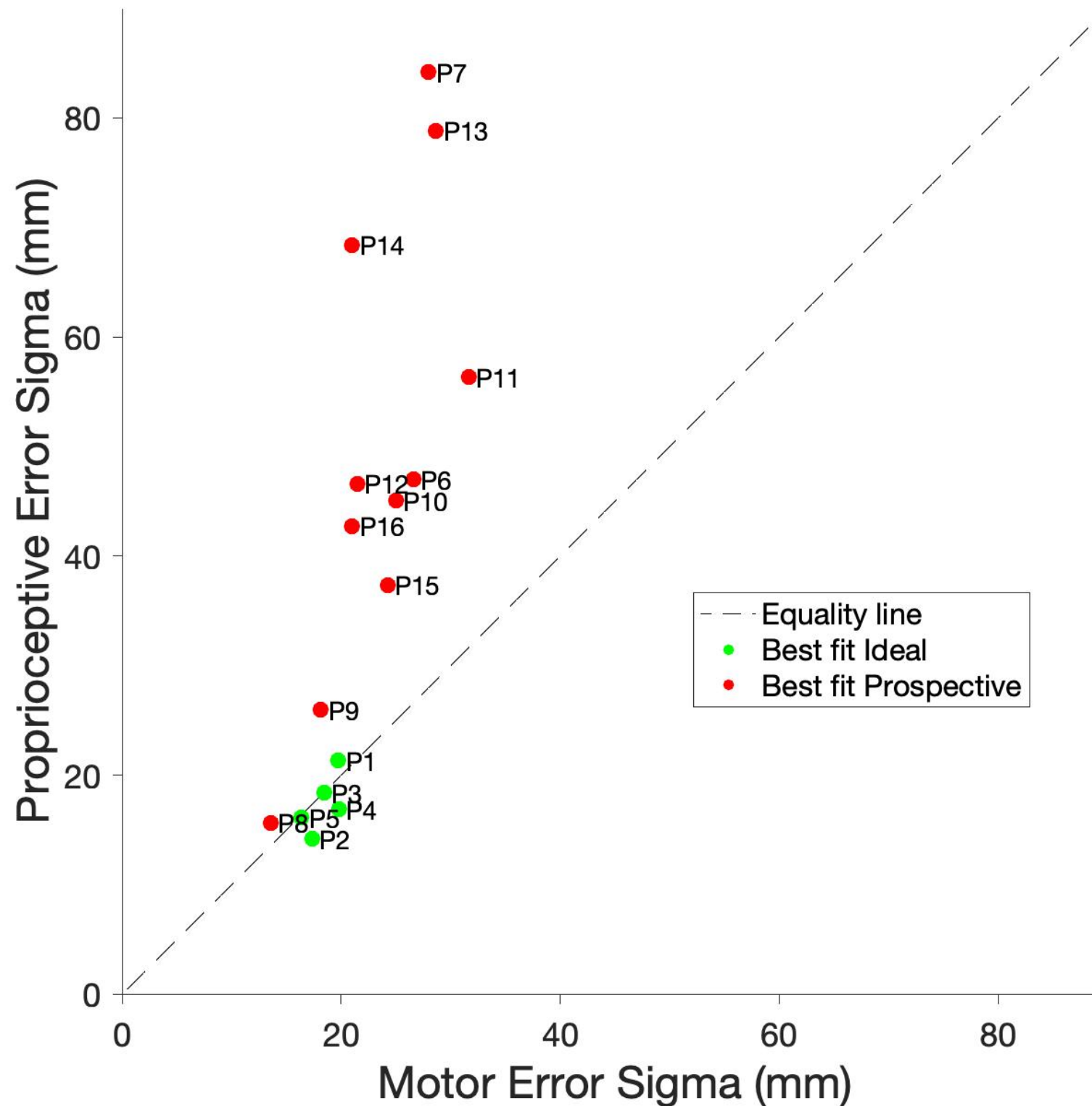
- Observers can use proprioception when prompted



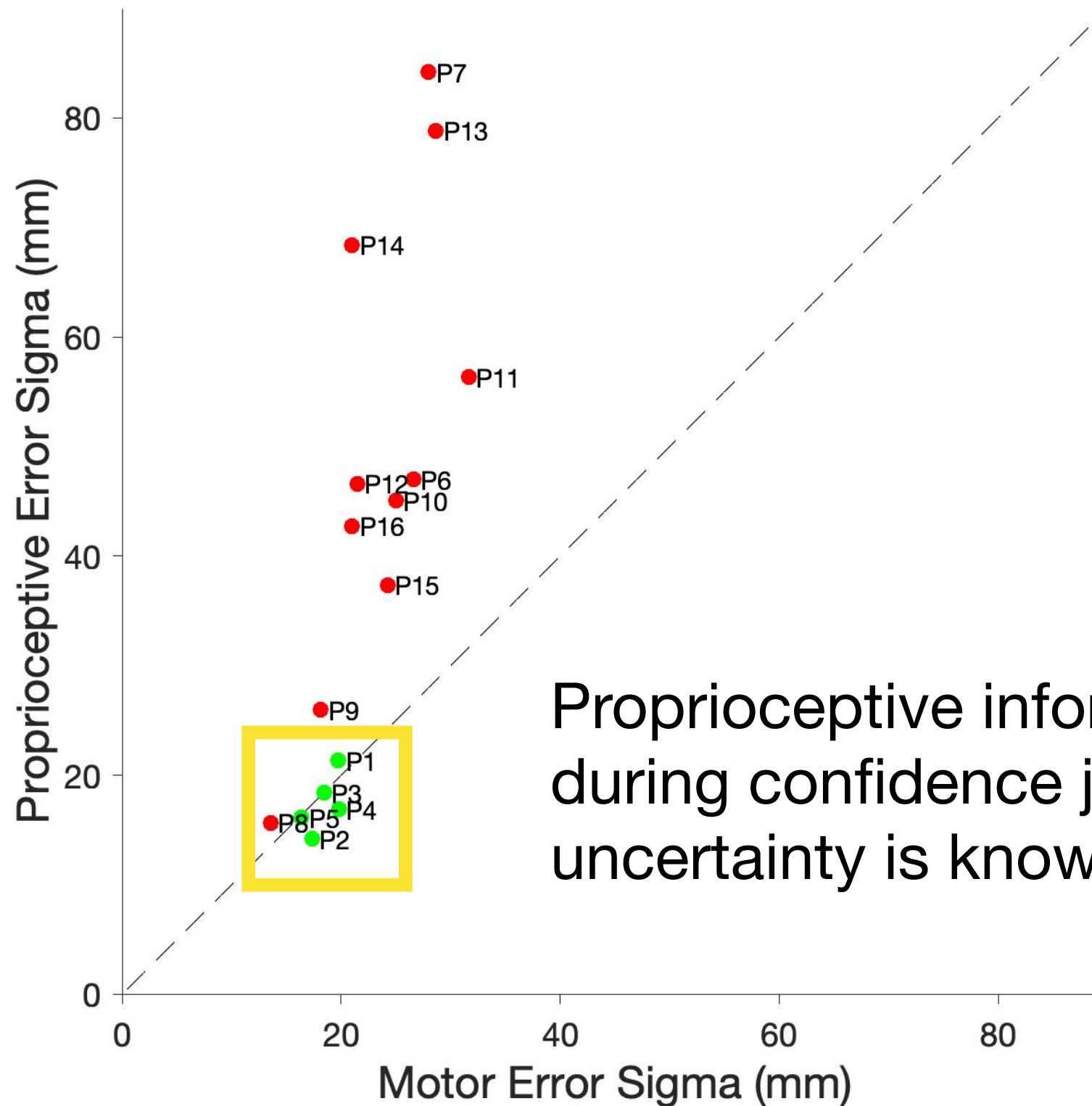
- Observers can use proprioception when prompted
- Proprioceptive information not always used when making a sensorimotor confidence judgment



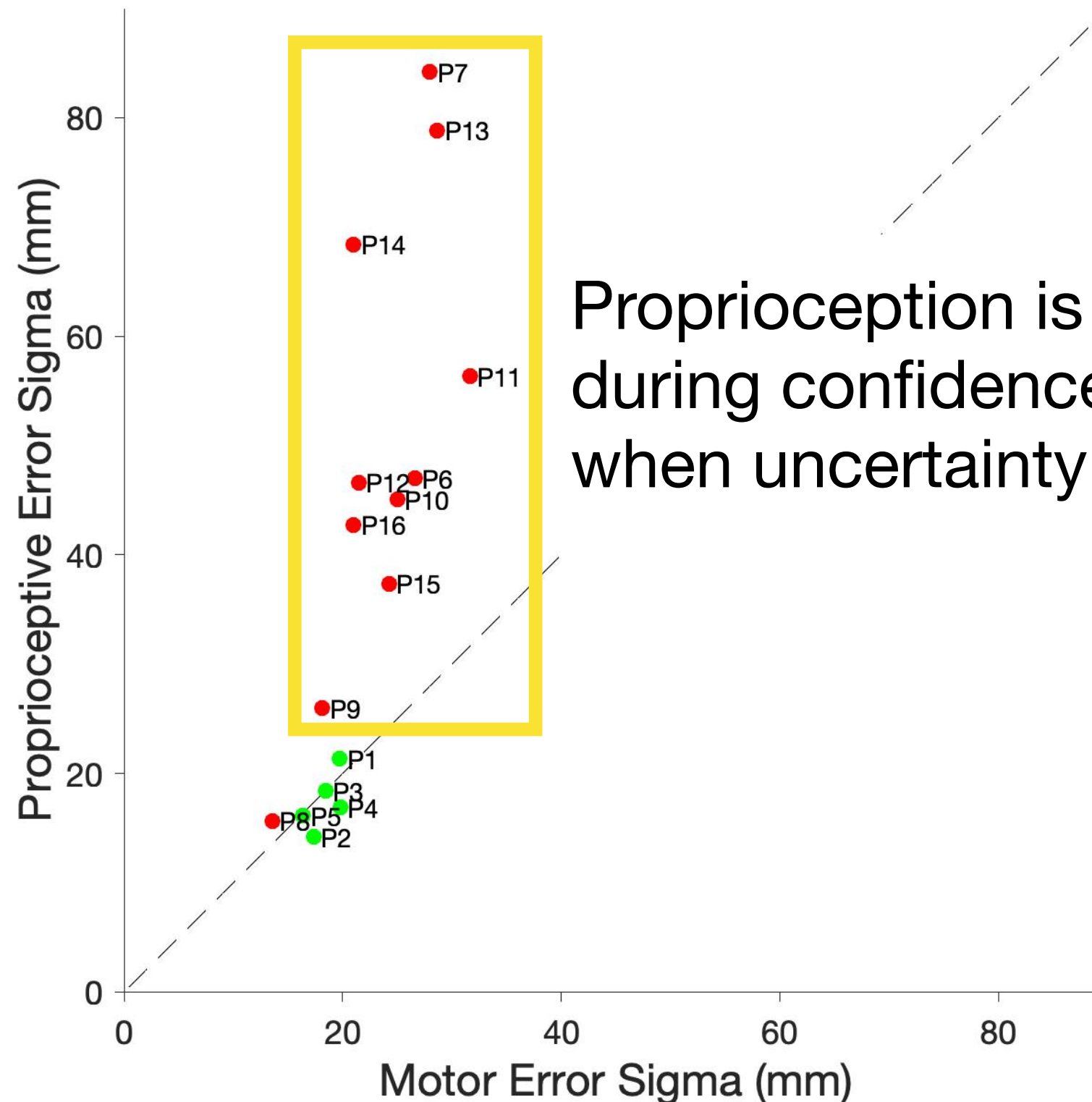
Best Fit Model Parameters



Best Fit Model Parameters



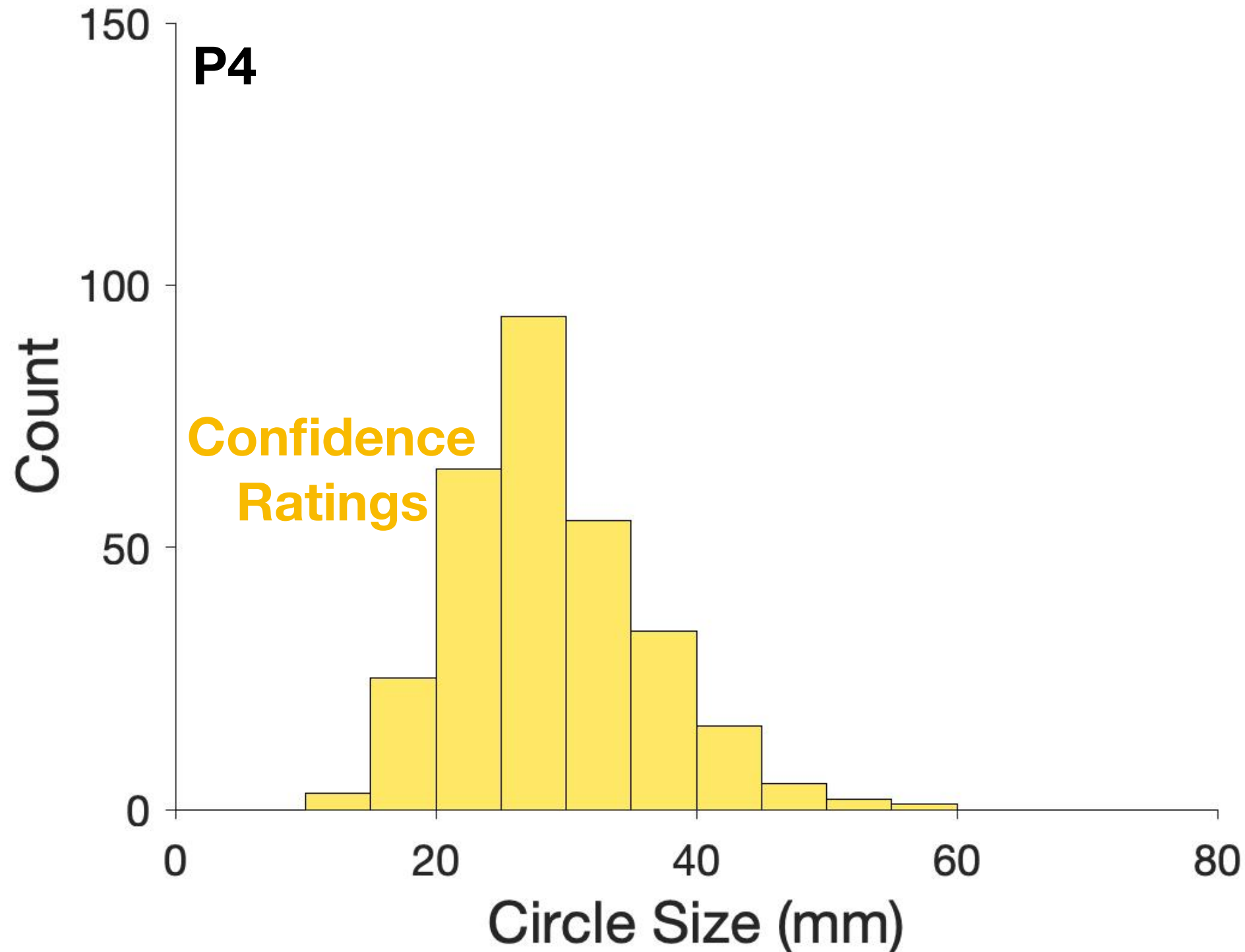
Best Fit Model Parameters



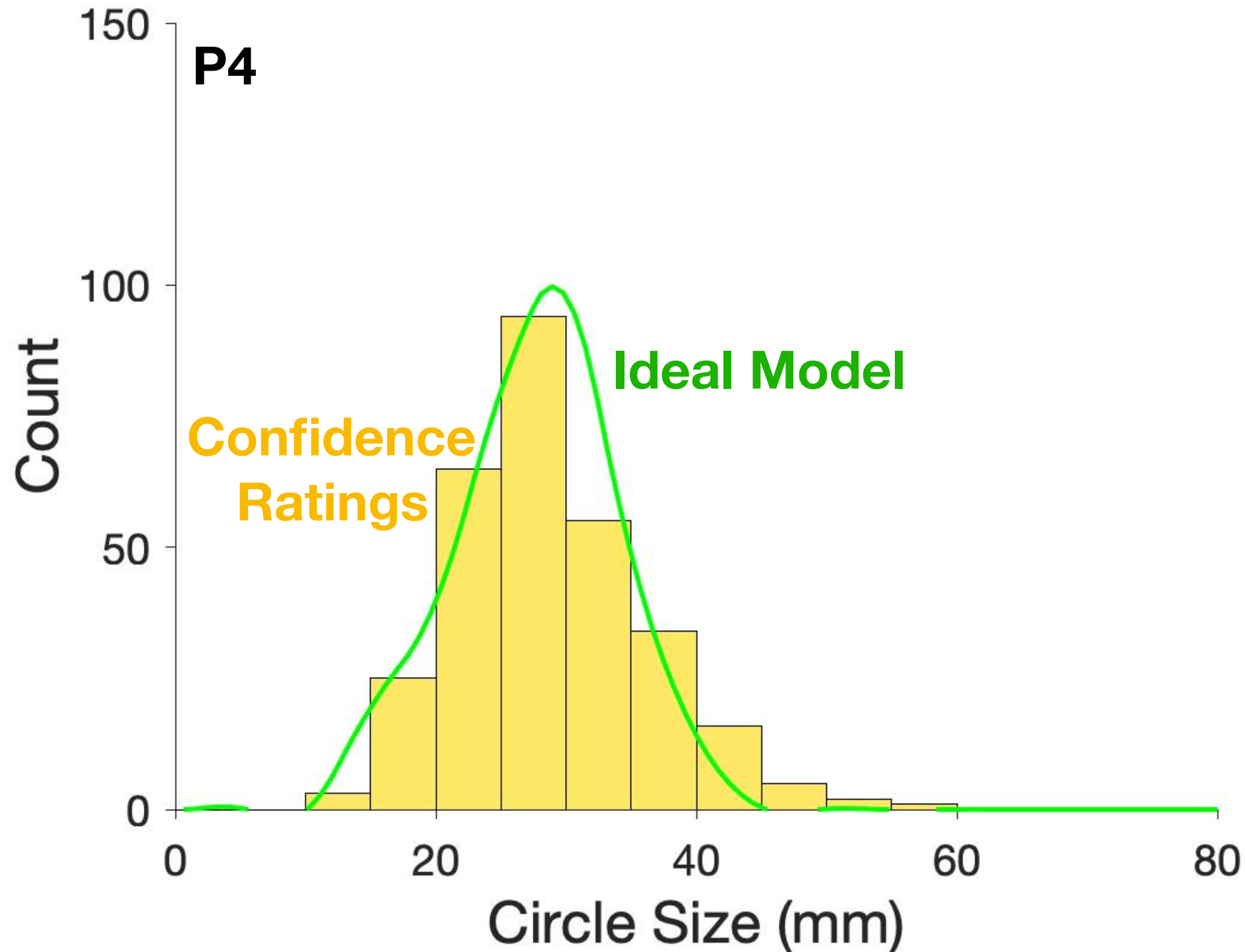
Proprioception is not used during confidence judgment when uncertainty is high

Comparing the models to data

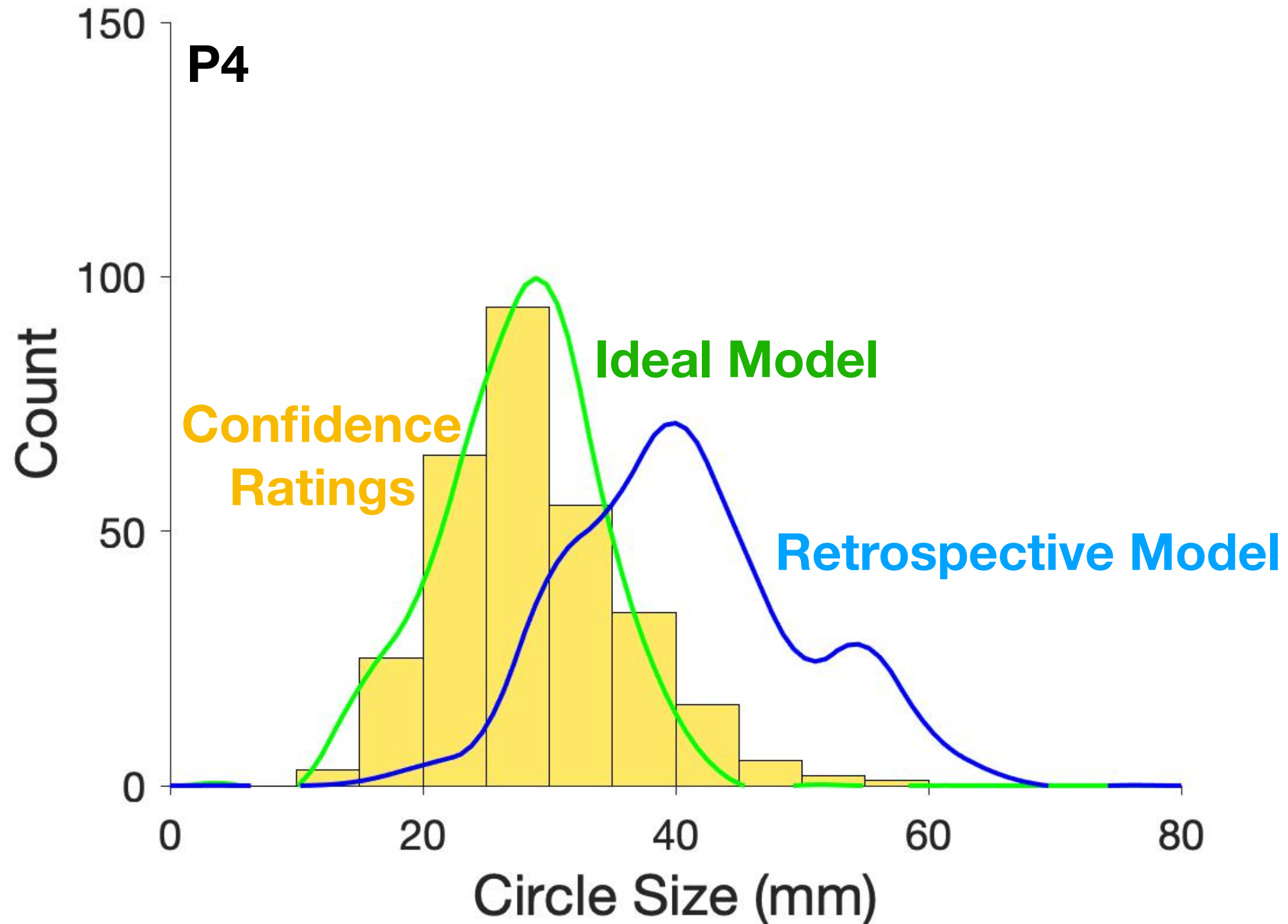
Model Predictions of Confidence



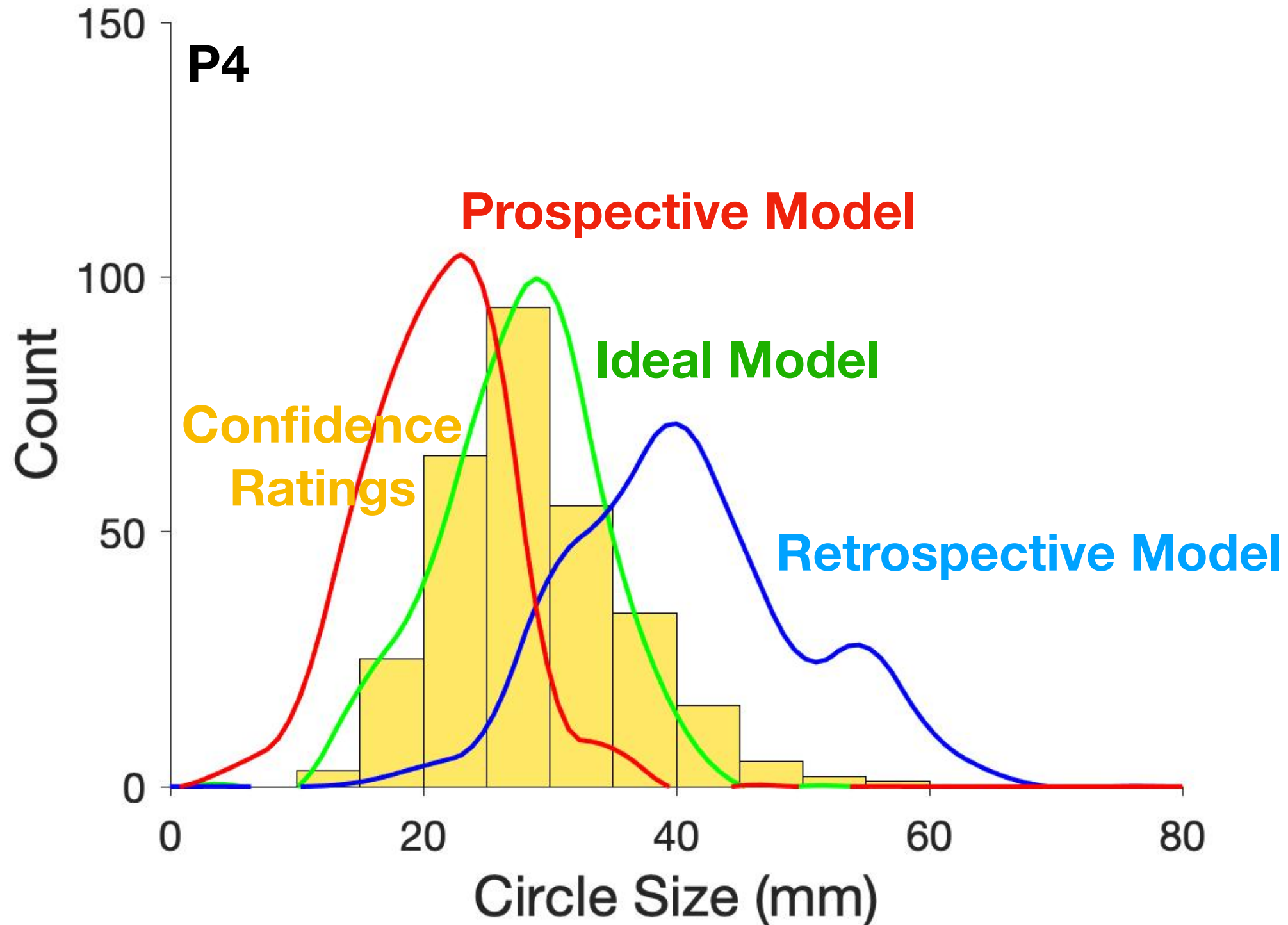
Model Predictions of Confidence



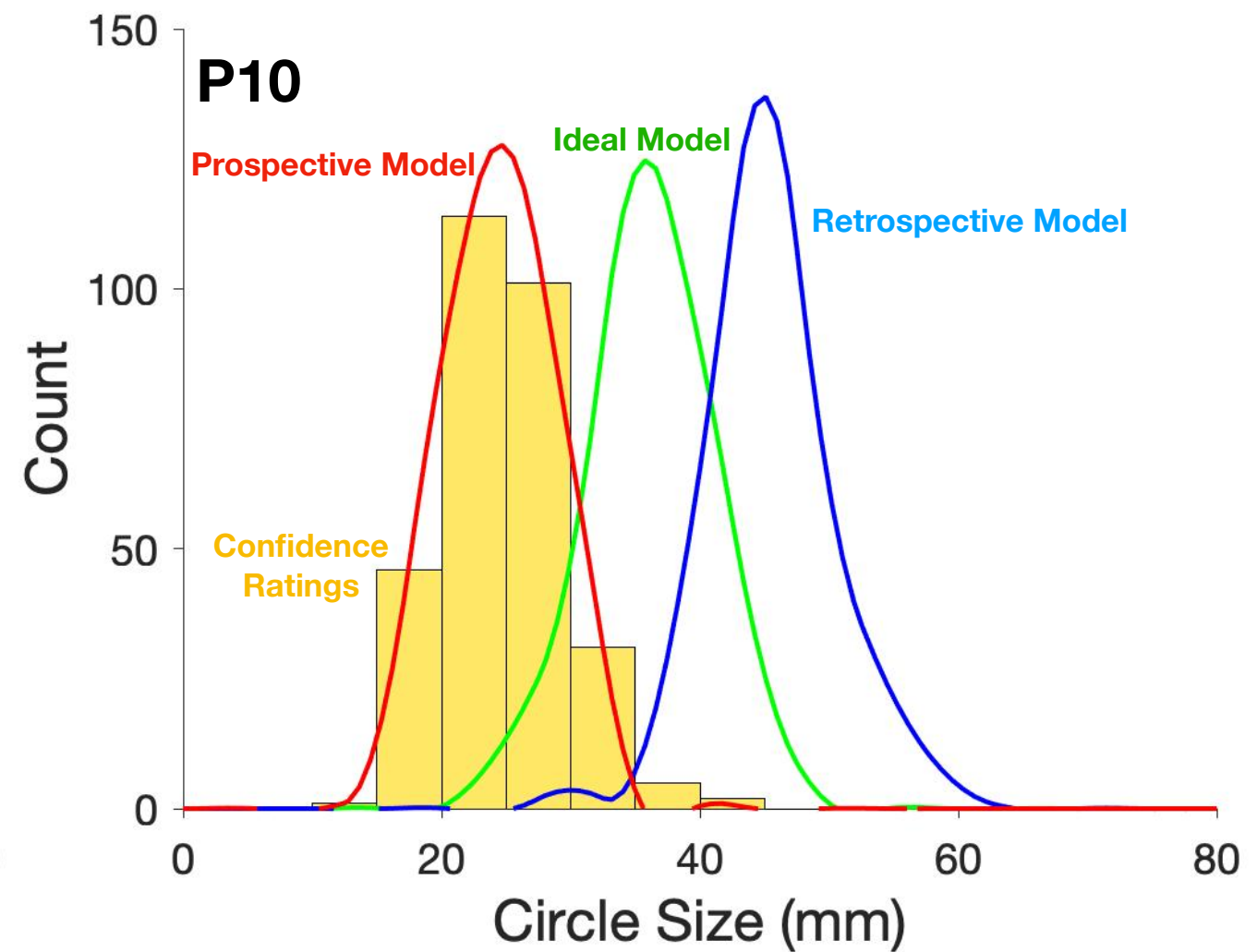
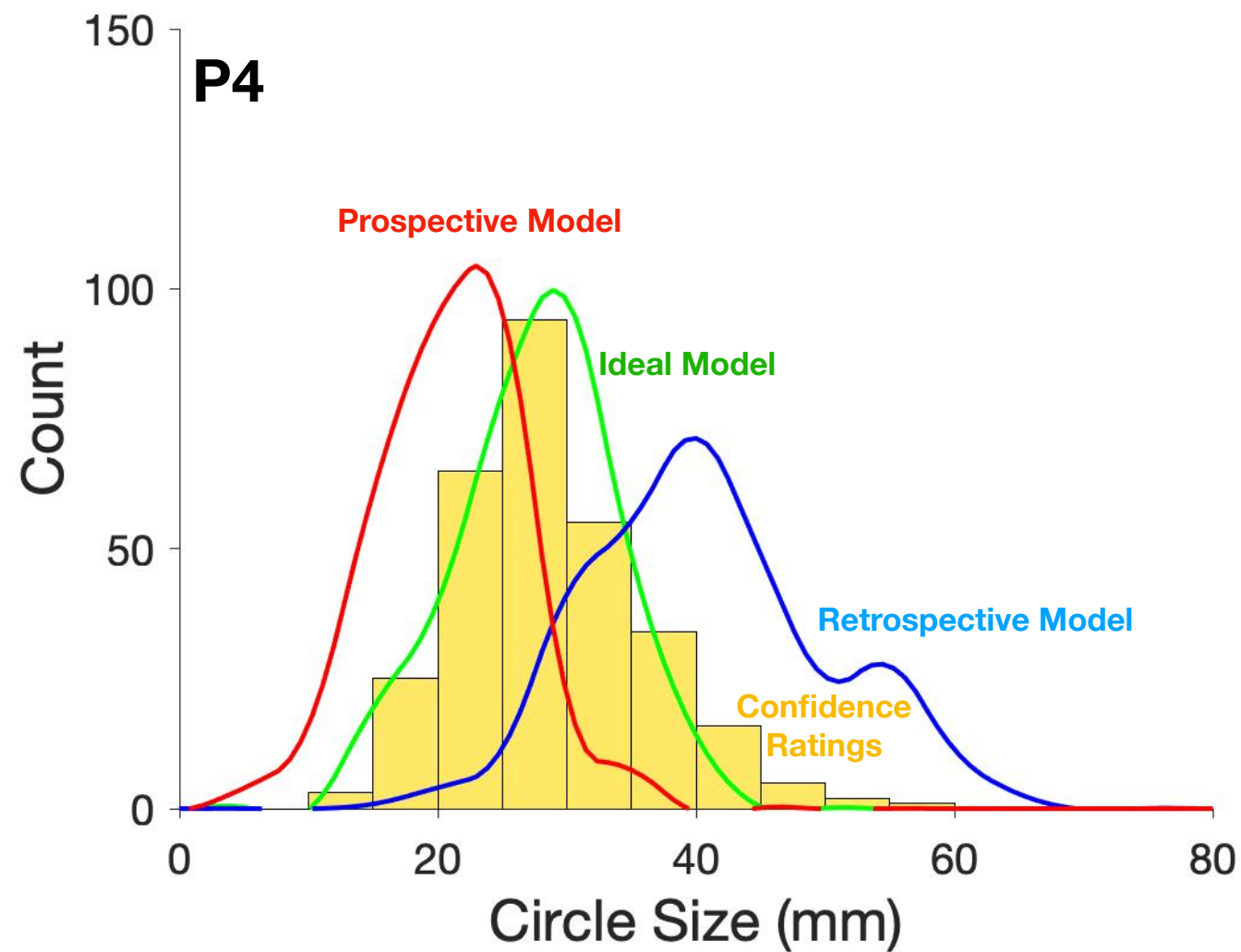
Model Predictions of Confidence



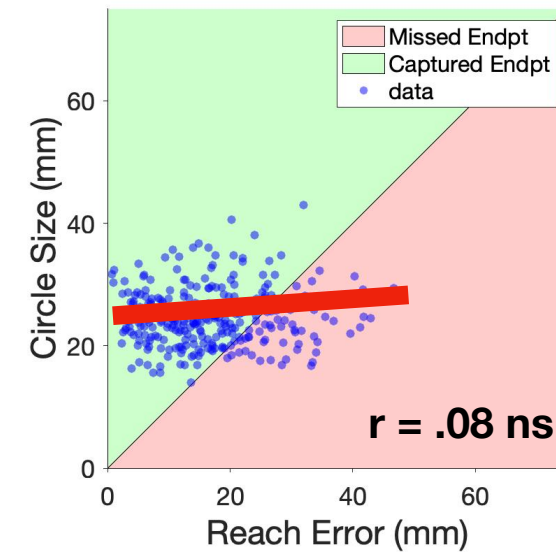
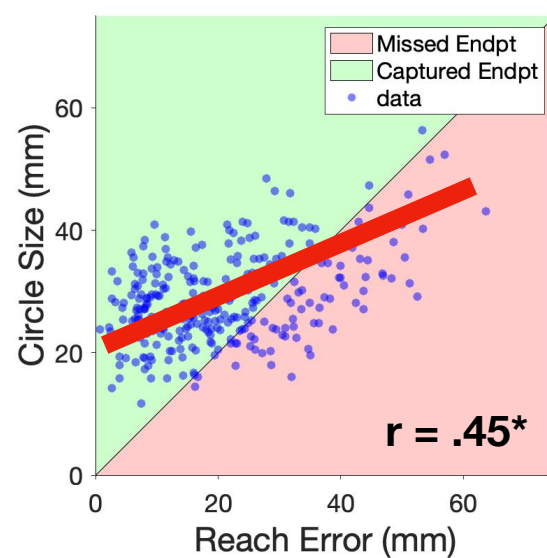
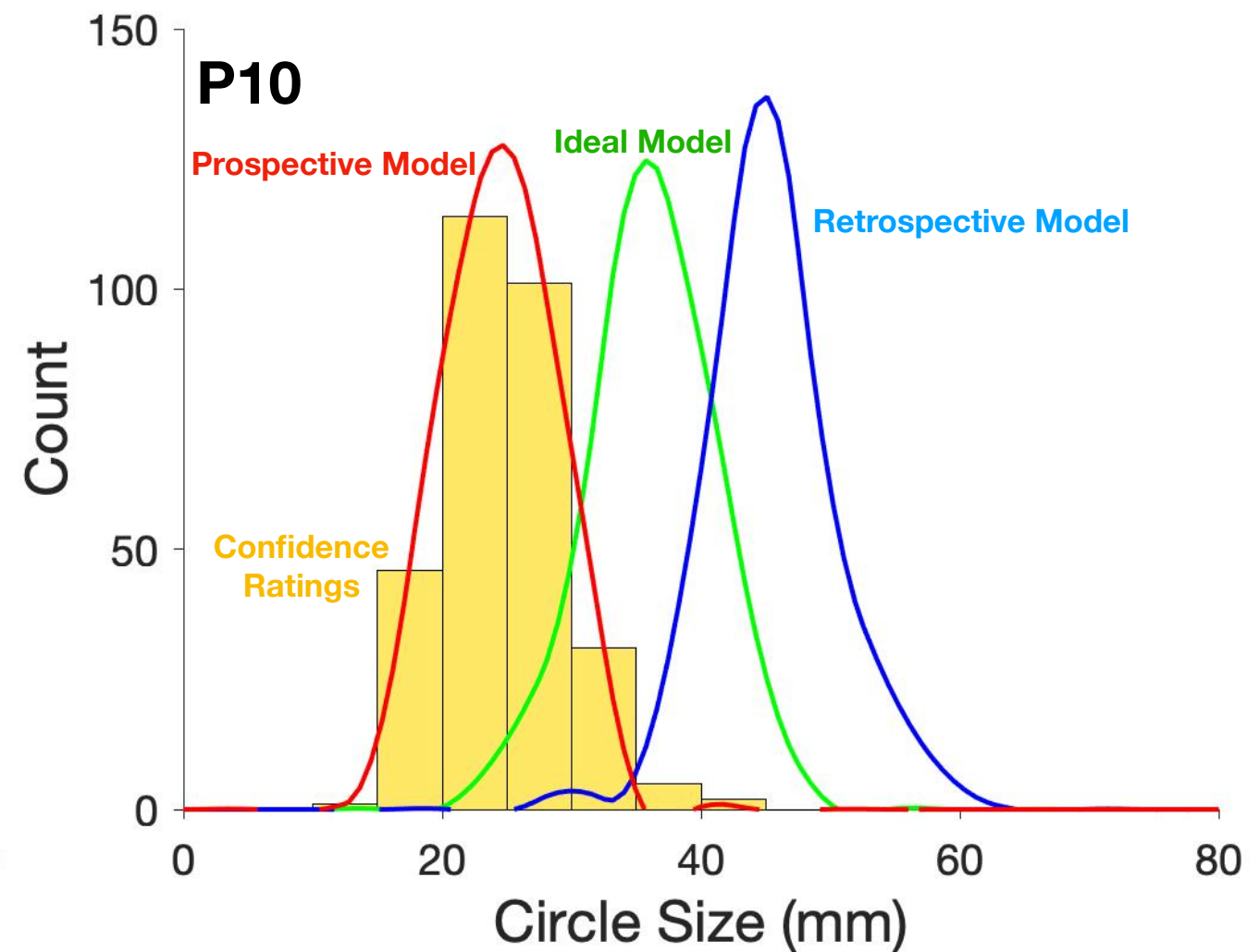
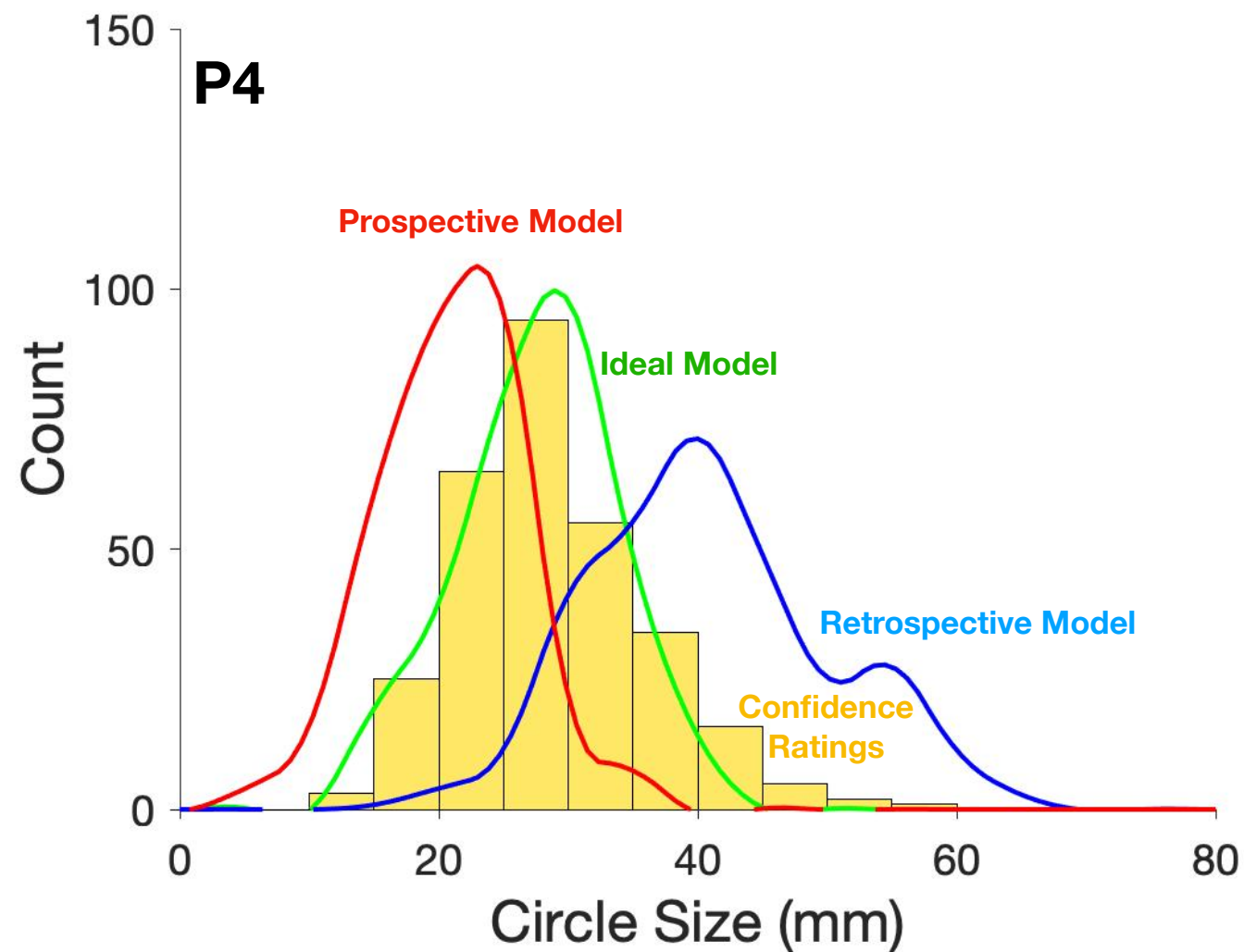
Model Predictions of Confidence

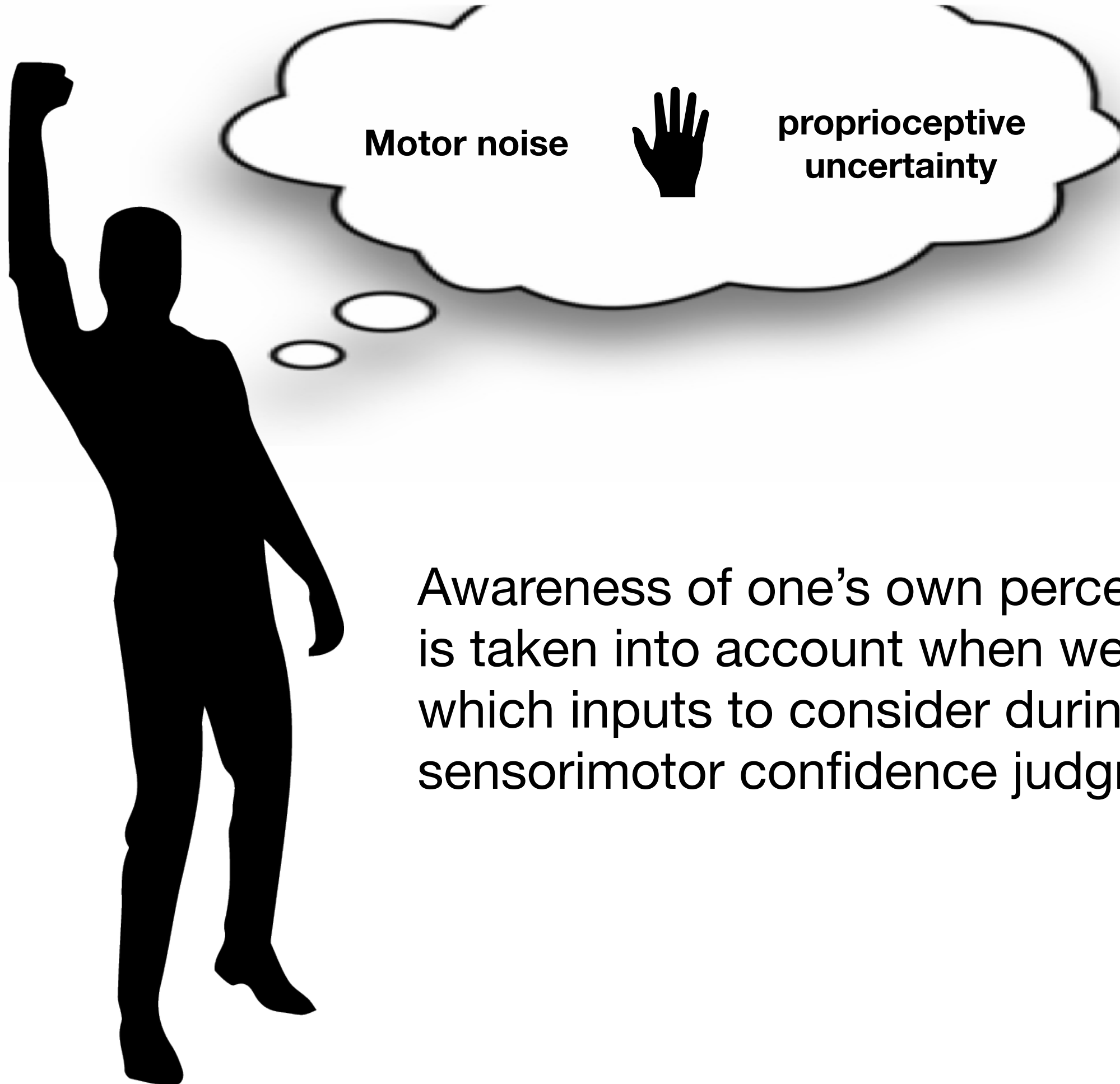


Model Predictions of Confidence



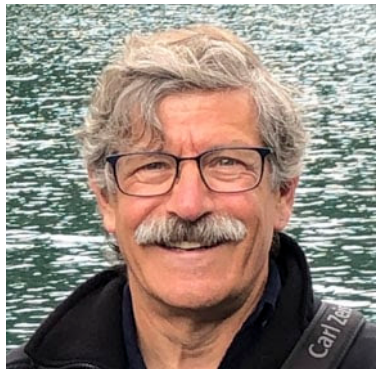
Model Predictions of Confidence





Awareness of one's own perceptual noise is taken into account when weighing which inputs to consider during a sensorimotor confidence judgment

Thank you!



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